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A SURVEY OF JP-8 AND JP-5 PROPERTIES

INTERIM REPORT
BFLRF No. 253

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By

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Contract No. DAAK70-87-C-0043

September 1988

045

Disclaimers

DTIC Availability Notice

Disposition Instructions

Unclassified
SECURITY CLASSIFICATION OF THIS PAGE

AD-A207721

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION Unclassified	1b. RESTRICTIVE MARKINGS None
2a. SECURITY CLASSIFICATION AUTHORITY N/A	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution unlimited
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) Interim Report BFLRF No. 253	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION Belvoir Fuels and Lubricants Research Facility (SwRI) — 6b. OFFICE SYMBOL (If applicable)	7a. NAME OF MONITORING ORGANIZATION
6c. ADDRESS (City, State, and ZIP Code) Southwest Research Institute 6220 Culebra Road San Antonio, Texas 78238	7b. ADDRESS (City, State, and ZIP Code)
8a. NAME OF FUNDING/SPONSORING ORGANIZATION U.S. Army Belvoir Research, Development and Engineering Center — 8b. OFFICE SYMBOL (If applicable) STRBE-VF	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER DAAK70-87-C-0043, WD 7
8c. ADDRESS (City, State, and ZIP Code) Fort Belvoir, VA 22060-5606	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. 63001 — PROJECT NO. 1L263001D150 — TASK NO. 07(7) — WORK UNIT ACCESSION NO.

11. TITLE (Include Security Classification)
A Survey of JP-8 and JP-5 Properties (U)

12. PERSONAL AUTHOR(S) Bowden, J.N.; Westbrook, S.R.; and M.E. LePera (U.S. Army Belvoir Research, Development and Engineering Center)

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Interim	FROM Oct 1987 TO Sep 1988	1988 September	109

16. SUPPLEMENTARY NOTATION

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)		
FIELD	GROUP	SUB-GROUP	Jet Fuel	JP-8	DF-1
			Aircraft Turbine Fuel	Diesel Fuel	DF-2
			JP-5	DF-A	F-54

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

With the help of the Defense Fuel Supply Center, JP-8, Jet A-1, and JP-5 samples from worldwide sources, representing tenders of products destined for Department of Defense bases, have been received at Belvoir Fuels and Lubricants Research Facility at Southwest Research Institute for evaluation. Inspection data for each sample on DD Form 250 or other data reporting form were also received and entered into a data base. The evaluation of these samples consisted of a few inspection tests for comparison with the data provided by the supplier, and tests related to the use of these fuels in diesel engines, which were measured cetane number, calculated cetane indices by two methods, net heat of combustion, and kinematic viscosity measurements at 40° and 70°C. The properties of these fuel samples were compared to the requirements of VV-F-800D diesel fuels, grades DF-A, DF-1, standard DF-2, and NATO F-54. Frequency histograms for most of the properties were developed and are presented. The JP-8 and JP-5 fuels meet most of the requirements of DF-A and DF-1.

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION Unclassified
22a. NAME OF RESPONSIBLE INDIVIDUAL Mr. T.C. Bowen	22b. TELEPHONE (Include Area Code) (703) 664-3576 — 22c. OFFICE SYMBOL STRBE-VF

DD FORM 1473, 84 MAR — 83 APR edition may be used until exhausted. All other editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE
Unclassified

EXECUTIVE SUMMARY

Problems and Objectives: Following the conversion of JP-4 to JP-8 for use in U.S. and NATO aircraft, the Department of Defense (DOD) has adopted the single fuel for the battlefield concept, i.e., the use of one fuel for combat in ground vehicles and equipment as well as in aircraft. It became important to determine the properties of the chosen fuel, JP-8, and other kerosene-type aircraft turbine fuels, JP-5 and Jet A-1, that pertain to their use in diesel-powered equipment.

Importance of Project: The evaluation of JP-8, JP-5, and Jet A-1 from worldwide sources was undertaken to assure the users of diesel-powered vehicles and equipment that these fuels can be used with no significant performance losses.

Technical Approach: To support this initiative, the Defense Fuel Supply Center requested that samples of JP-8, JP-5, and Jet A-1 from worldwide sources representing tenders of products destined for DOD bases be supplied to the Belvoir Fuels and Lubricants Research Facility at Southwest Research Institute for evaluation. Since use of these products as diesel fuels was the primary interest of this survey, those properties affecting diesel engine operation were evaluated, i.e., cetane number, calculated cetane indexes, kinematic viscosities at 40° and 70°C, and volumetric net heat of combustion. These properties were compared to the requirements of Federal Specification VV-F-800D for diesel fuel Grades DF-A, DF-1, DF-2, and NATO F-54, the latter of which is the standard diesel fuel used by all NATO forces. Several inspection tests were also conducted on the samples, and the data were compared to that supplied by the refiners.

Accomplishments: In this program, 93 samples of JP-8, which included 2 Jet A-1 and 63 JP-5 samples, were analyzed. Frequency histograms and other statistics for many properties were developed and are presented. The data indicate that many of the JP-8 fuels being supplied in Europe meet the DF-1 viscosity requirements, and several even fall in the DF-A viscosity range. Virtually all samples had cetane numbers of 40 and above. The JP-5 fuels being supplied in the U.S. meet the viscosity requirements for DF-1, but many have cetane numbers below the 40 minimum requirement. The net heat of combustion values for the JP-8 and JP-5 fuels tend to be lower than those for DF-2, NATO F-54, and EPA certification diesel fuels.

Based on estimated volumetric net heat of combustion values for DF-2, NATO F-54, and EPA certification diesel fuels, and measured values for JP-8 and JP-5, it would appear that fuel consumption may increase when using aircraft turbine fuels in some diesel engines. However, some of the other anticipated benefits in using these fuels such as reduced nozzle fouling, reduced filter plugging, improved low-temperature handling characteristics, etc. may offset this lowered heat of combustion characteristic. A primary area of concern addressed in this survey was the cetane quality of these jet kerosene fuels and the cetane index method that best predicts the cetane number. Based upon this sampling, the ASTM D 976, Calculated Cetane Index, procedure provided better correlation than the ASTM D 4737, Calculated Cetane Index by Four Variable Equation, method.

Military Impact: The results of this survey provided data to show that aircraft kerosene-type fuels (JP-8, Jet A-1, and JP-5) can be used in diesel-powered equipment with assurance that no catastrophic fuel-related failures will occur, although an increase in fuel consumption may be observed. The two major benefits anticipated will be the elimination of the need to provide more than one fuel for combat and assurance that the fuel in the vehicles will not gel due to wax crystallization during severe cold weather.

FOREWORD

This work was performed at the Belvoir Fuels and Lubricants Research Facility, Southwest Research Institute, under DOD Contract No. DAAK70-87-C-0043. The project was administered by the Fuels and Lubricants Division, U.S. Army Belvoir Research, Development and Engineering Center, Ft. Belvoir, VA 22060-5606, with Mr. T.C. Bowen, STRBE-VF, serving as Contracting Officers' Representative, and Mr. M.E. LePera, Chief of Fuels and Lubricants Division (STRBE-VF), the project technical monitor. This report covers the period of performance from October 1987 through September 1988.

The efforts of Ms. Lona Bundy in collecting and tabulating the data for this project, and those of Mr. Jim Pryor, Ms. Cindy Sturrock, Sherry Douvry, and LuAnn Pierce for their editorial contributions to this report, are greatly appreciated by the authors. The assistance provided by Ms. Margaret Millikin in preparing the statistical plots is appreciated. The technical guidance and review provided by Mr. S.J. Lestz during the performance of this project are acknowledged.

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I. INTRODUCTION

For over 20 years, the U.S. Army has been converting the tactical vehicle fleet to diesel- and turbine-powered engines, and the primary fuel for these engines is Federal Specification VV-F-800D, Fuel Oil, Diesel, Grade DF-2, which is interchanged under NATO Code F-54. Consequently, this fuel is used in the Army's ground vehicles, generators, and other engine-powered equipment, as well as in the Navy and Air Forces' ground equipment. During the winter of 1981-1982, much of the Army's fleet in Europe was inoperable as the severe cold weather caused the fuel in lines and in fuel cells to congeal due to wax separation. During that and subsequent winters, this problem was virtually eliminated by blending F-54 diesel fuel with a kerosene-type fuel such as JP-5 or JP-8, thus reducing the cloud and pour points of the fuel. The blend of equal parts of DF-2 (NATO F-54) and either JP-5 (NATO F-44), JP-8 (NATO F-34), or ASTM Jet A-1 (F-35), initially called the "M-1 Fuel Mix," was recently assigned a new NATO code number F-65. In recent years, the NATO forces have adopted the use of JP-8 in their aircraft throughout the European Theater, replacing the more volatile JP-4 fuel. In 1975, a report entitled "Universal Fuel Requirements" recommended JP-8 as the fuel to be used year round and world wide in the Army's diesel- and turbine-powered equipment.(1)* The Navy had investigated the use of JP-5 in many of its diesel-powered vehicles.(2-4) JP-5 and JP-8 are both kerosenes fuels in the same boiling range, the principal difference being in the flash point minimum limit. JP-8 has a $38^{\circ}C$ minimum limit and the JP-5 limit is $60^{\circ}C$ minimum, primarily because of the shipboard application. The report "JP-8 and JP-5 as Compression Ignition Engine Fuels," published in 1985 by Belvoir Fuels and Lubricants Research Facility (BFLRF) located at Southwest Research Institute (SwRI) confirmed the feasibility of using JP-8 in lieu of F-54.(5) Recently, the "One-Fuel-Forward" concept (6) has emerged, and considerable work has been conducted on the application of JP-8 to the various Army engines. Both JP-8 and JP-5 are designated alternate fuels for use in compression ignition and turbine engines in the Army Regulation AR-703-1; however, DF-2 remains as the primary fuel.(7)

* Underscored numbers in parentheses refer to the list of references at the end of this report.

II. OBJECTIVE

The objective of this program was to determine the range of values found for certain properties of JP-8 and JP-5 that are important for compression ignition engine operation but are not determined for fuels procured for aircraft turbine engine application.

III. APPROACH

The thrust of this work was to measure, on a wide range of JP-8 and JP-5 samples, those properties pertaining to diesel engine operation that are not reported for aircraft turbine fuels. The properties of major interest were: the cetane qualities of JP-8/JP-5 fuels, the cetane index correlation procedure most suitable for these fuels, the viscosities at temperatures that can be related to fuel injection pump and diesel engine operating temperatures, and the volumetric heat content to provide an indication of fuel consumption. Beginning in March 1987, the Defense Fuel Supply Center (DFSC) requested that all suppliers of JP-8, JP-5, and Jet A-1 provide 1-gallon sample from each tender, and a copy of the DD Form 250 or equivalent containing the test data for the respective tender, to BFLRF for analytical evaluation. The ASTM procedures used were cetane number by D 613, calculated cetane index by D 976 and by D 4737, kinematic viscosities at 40° and 70°C by D 445, and net heat of combustion by D 240. For comparison with the data provided by the refiners, the following ASTM tests were selected for determinations on the samples received: API gravity and density by D 1298, color by D 156, flash point by D 93, distillation by D 86, and sulfur by nondispersive X-ray fluorescence spectrometry - D 4294.

A similar survey on a smaller scale, in which samples of JP-5, Jet A, and Jet A-1 were obtained from refiners and evaluated for diesel fuel as well as aircraft turbine fuel properties, had been conducted at BFLRF and reported in 1982.(8)

IV. DISCUSSION OF RESULTS

A. Properties of JP-8 Samples Evaluated

A total of 91 samples of JP-8 and 2 of Jet A-1 representing tenders of these products obtained through DFSC were received at BFLRF and evaluated for selected properties as described in Section III. Most of the samples came from refineries in Europe, and their sources were identified as follows:

Location	No. of Samples
Britain	1
Killingholme, England	2
Greece	1
St. Theodori, Greece	21
Athens, Greece	1
Huelva, Spain	11
Norco, Louisiana	2
Singapore	1
Rotterdam, Netherlands	26
Port Jerome, France	9
Priolo, Sicily	8
Castallon, Spain	3
West Germany	4
Pohang, Korea (Jet A-1)	2
Ft. Belvoir, VA (from PM Mobile Electric Power Office)	1

TABLE 1 lists the JP-8 samples evaluated, showing their identification code, source, date sampled (if known) and date received at BFLRF. The Jet A-1 fuels are included in this list and throughout the report with the JP-8 samples. The data of special interest to this program are presented in TABLE 2, which is divided into two parts. In Part 1 are those analytical properties that were measured primarily for comparison with the suppliers' data. Part 2 contains the data more closely related to the utilization of JP-8 as a diesel fuel. TABLE 3 contains partial specification requirements for JP-8, arctic diesel fuel (DF-A), DF-1, and NATO F-54, as well a summary of the data in Parts 1 and 2 of TABLE 2, and shows average, maximum, and minimum values and standard deviation for each property.

TABLE 1. Source of JP-8 Samples

Lab Code	Location	Sample Date	Date Received
AL-15050-F	Britain	---	04-28-86
AL-15854-F	Greece	---	02-17-87
AL-15996-F	St Theodori, Greece	03-30-87	04-14-87
AL-16025-F	St Theodori, Greece	04-07-87	04-28-87
AL-16064-F	Huelva, Spain	04-13-87	05-18-87
AL-16091-F	Norco, Louisiana	05-20-87	05-29-87
AL-16234-F	Singapore	05-11-87	06-26-87
AL-16236-F	Norco, Louisiana	06-23-87	06-29-87
AL-16242-F	Ft. Belvoir, Virginia	---	07-07-87
AL-16253-F	Rotterdam, Netherlands	06-02-87	07-09-87
AL-16254-F	Rotterdam, Netherlands	06-11-87	07-09-87
AL-16255-F	Rotterdam, Netherlands	06-24-87	07-09-87
AL-16256-F	Rotterdam, Netherlands	06-24-87	07-09-87
AL-16418-F	Huelva, Spain	06-16-87	07-17-87
AL-16449-F	Rotterdam, Netherlands	07-13-87	07-30-87
AL-16450-F	Rotterdam, Netherlands	07-13-87	07-30-87
AL-16466-F	St Theodori, Greece	07-22-87	08-11-87
AL-16536-F	Rotterdam, Netherlands	08-13-87	08-25-87
AL-16662-F	St Theodori, Greece	09-07-87	09-18-87
AL-16663-F	St Theodori, Greece	09-01-87	09-18-87
AL-16676-F	Huelva, Spain	08-17-87	09-24-87
AL-16677-F	Port Jerome, France	08-27-87	09-24-87
AL-16741-F	Rotterdam, Netherlands	09-10-87	10-07-87
AL-16742-F	Rotterdam, Netherlands	09-13-87	10-07-87
AL-16743-F	Rotterdam, Netherlands	09-07-87	10-07-87
AL-16770-F	Port Jerome, France	10-04-87	10-15-87
AL-16771-F	St Theodori, Greece	09-27-87	10-15-87
AL-16844-F	Port Jerome, France	10-22-87	11-18-87
AL-16965-F	Priolo, Sicily	11-14-87	12-09-87
AL-17034-F	Port Jerome, France	12-03-87	12-15-87
AL-17042-F	Rotterdam, Netherlands	11-30-87	12-22-87
AL-17087-F	Castellon, Spain	12-01-87	01-07-88
AL-17102-F	Pohang, Korea (Jet-A-1)	11-16-87	01-13-88
AL-17107-F	Pohang, Korea (Jet-A-1)	11-23-87	01-13-88
AL-17114-F	St Theodori, Greece	11-30-87	01-18-88
AL-17115-F	St Theodori, Greece	11-04-87	01-18-88
AL-17129-F	Rotterdam, Netherlands	01-01-88	01-28-88
AL-17130-F	Rotterdam, Netherlands	12-29-87	01-28-88
AL-17131-F	Rotterdam, Netherlands	12-31-87	01-28-88
AL-17132-F	Rotterdam, Netherlands	01-01-88	01-28-88
AL-17186-F	Priolo, Sicily	01-02-88	02-03-88
AL-17215-F	Port Jerome, France	01-15-88	02-08-88
AL-17220-F	Castellon, Spain	01-11-88	02-10-88
AL-17228-F	St Theodori, Greece	01-13-88	02-17-88
AL-17229-F	St Theodori, Greece	01-26-88	02-17-88
AL-17230-F	St Theodori, Greece	12-21-87	02-17-88
AL-17231-F	Priolo, Sicily	01-25-88	02-18-88

TABLE 1. Source of JP-8 Samples (Continued)

Lab Code	Location	Sample Date	Date Received
AL-17259-F	Port Jerome, France	02-14-88	02-24-88
AL-17260-F	Priolo, Sicily	02-08-88	02-24-88
AL-17409-F	Port Jerome, France	02-08-88	02-24-88
AL-17426-F	St. Theodori, Greece	02-23-88	03-29-88
AL-17493-F	Rotterdam, Netherlands	02-18-88	04-01-88
AL-17494-F	Rotterdam, Netherlands	03-01-88	04-01-88
AL-17495-F	Rotterdam, Netherlands	02-27-88	04-01-88
AL-17498-F	Rotterdam, Netherlands	03-14-88	04-05-88
AL-17505-F	Priolo, Sicily	03-27-88	04-07-88
AL-17533-F	St. Theodori, Greece	03-15-88	04-20-88
AL-17534-F	St. Theodori, Greece	03-15-88	04-20-88
AL-17542-F	West Germany	04-18-88	04-25-88
AL-17591-F	Rotterdam, Netherlands	03-30-88	05-09-88
AL-17592-F	Rotterdam, Netherlands	03-30-88	05-09-88
AL-17593-F	St. Theodori, Greece	04-25-88	05-09-88
AL-17594-F	St. Theodori, Greece	04-05-88	05-09-88
AL-17601-F	West Germany	04-27-88	05-12-88
AL-17616-F	Castellon, Spain	03-27-88	05-17-88
AL-17617-F	Huelva, Spain	01-04-88	05-17-88
AL-17618-F	Huelva, Spain	02-09-88	05-17-88
AL-17619-F	Huelva, Spain	01-21-88	05-17-88
AL-17623-F	Rotterdam, Netherlands	04-24-88	05-19-88
AL-17624-F	Rotterdam, Netherlands	03-14-88	05-19-88
AL-17625-F	Rotterdam, Netherlands	04-18-88	05-19-88
AL-17627-F	Priolo, Sicily	04-11-88	05-20-88
AL-17638-F	Port Jerome, France	05-04-88	05-24-88
AL-17725-F	West Germany	05-27-88	06-08-88
AL-17736-F	St. Theodori, Greece	05-13-88	06-14-88
AL-17737-F	St. Theodori, Greece	05-22-88	06-14-88
AL-17738-F	St. Theodori, Greece	05-27-88	06-14-88
AL-17767-F	Priolo, Sicily	05-25-88	06-21-88
AL-17792-F	Port Jerome, France	06-16-88	06-29-88
AL-17828-F	Huelva, Spain	06-15-88	07-18-88
AL-17829-F	Huelva, Spain	06-15-88	07-18-88
AL-17830-F	Huelva, Spain	06-23-88	07-18-88
AL-17835-F	West Germany	06-29-88	07-19-88
AL-17907-F	Killingholme, England	07-11-88	07-27-88
AL-17908-F	Killingholme, England	07-11-88	07-27-88
AL-18105-F	St. Theodori, Greece	06-25-88	07-29-88
AL-18116-F	Rotterdam, Netherlands	07-13-88	08-01-88
AL-18123-F	Priolo, Sicily	07-02-88	08-08-88
AL-18133-F	Huelva, Spain	07-14-88	08-16-88
AL-18134-F	Huelva, Spain	07-14-88	08-16-88
AL-18144-F	Athens, Greece	07-26-88	08-23-88
AL-18147-F	Rotterdam, Netherlands	08-04-88	08-24-88
AL-18157-F	Rotterdam, Netherlands	08-12-88	09-01-88

TABLE 2. Selected Characteristics of DFSC Samples of JP-8 (Part 1)

Lab Code	Gravity, °API, D 1298	Density, kg/L, D 1298	Color, D 156	Flash Point, °C, D 93	Distillation, D 86					Sulfur, mass%, D 4294
					IBT	10%	50%	90%	EP	
AL-15050-F	43.2	0.810	+23	51	159	181	211	246	275	0.05
AL-15854-F	46.1	0.796	0	46	156	174	198	232	256	0.07
AL-15996-F	46.0	0.797	+17	42	149	169	198	239	259	0.20
AL-16025-F	45.9	0.797	+30	42	153	173	198	236	259	0.12
AL-16064-F	42.6	0.812	+11	48	159	176	209	250	276	0.08
AL-16091-F	41.5	0.818	+30	48	161	179	209	246	266	0.03
AL-16234-F	44.8	0.802	+30	42	149	166	202	253	281	0.08
AL-16236-F	41.9	0.816	+30	51	163	182	209	244	263	0.02
AL-16242-F	41.3	0.819	-16	47	169	184	222	253	297	0.05
AL-16253-F	46.5	0.795	> +30	51	166	180	202	237	260	< 0.01
AL-16254-F	43.9	0.806	+30	49	163	181	207	243	267	< 0.01
AL-16255-F	45.8	0.798	+30	48	165	179	204	240	264	< 0.01
AL-16256-F	43.6	0.808	+30	49	164	181	208	243	271	< 0.01
AL-16418-F	45.1	0.801	+30	54	172	188	210	239	262	0.13
AL-16449-F	45.5	0.799	+30	49	164	180	206	242	264	< 0.01
AL-16450-F	45.3	0.800	+30	51	166	181	212	241	266	< 0.01
AL-16466-F	45.6	0.799	0	39	149	172	202	240	260	0.23
AL-16536-F	45.5	0.799	+30	51	167	182	204	237	261	< 0.01
AL-16662-F	46.0	0.797	+2	43	154	173	199	234	256	0.16
AL-16663-F	45.1	0.801	+2	43	157	176	203	238	261	0.18
AL-16676-F	41.4	0.818	+19	51	163	183	213	249	276	0.03
AL-16677-F	46.2	0.796	+30	41	148	173	196	227	248	0.06
AL-16741-F	46.2	0.796	> +30	51	161	179	202	235	263	< 0.01
AL-16742-F	45.8	0.798	> +30	51	163	180	202	237	258	< 0.01
AL-16743-F	46.2	0.796	> +30	48	158	176	199	236	260	< 0.01
AL-16770-F	47.4	0.791	+30	36	151	170	193	225	248	0.04
AL-16771-F	46.6	0.794	+15	41	155	172	199	234	253	0.18
AL-16844-F	46.9	0.793	+30	41	147	168	192	224	239	0.06
AL-16965-F	46.6	0.794	> +30	41	153	171	194	226	251	0.10
AL-17034-F	47.6	0.790	+30	39	144	173	195	223	235	0.07
AL-17042-F	45.1	0.801	> +30	51	163	178	203	242	263	< 0.01
AL-17087-F	42.7	0.812	+30	46	154	173	206	246	261	0.15
AL-17102-F	46.3	0.796	> +30	47	156	170	189	222	238	0.05
AL-17107-F	47.4	0.791	> +30	41	152	166	183	216	245	0.09
AL-17114-F	47.1	0.792	+17	42	154	173	195	229	251	0.13
AL-17115-F	47.1	0.792	+17	43	153	173	194	229	249	0.12
AL-17129-F	46.3	0.796	+30	52	167	182	203	238	271	< 0.01
AL-17130-F	46.1	0.796	+30	49	164	179	202	238	268	< 0.01
AL-17131-F	44.9	0.802	+30	49	163	179	204	242	275	< 0.01
AL-17132-F	45.7	0.798	+30	50	164	180	203	239	269	< 0.01
AL-17186-F	49.3	0.782	+30	38	151	167	186	221	250	0.11
AL-17215-F	46.9	0.793	+30	37	150	172	194	225	254	0.06
AL-17220-F	42.0	0.815	+30	41	144	167	204	248	274	0.10
AL-17228-F	45.3	0.800	+12	43	151	174	200	234	253	0.13
AL-17229-F	46.3	0.796	+17	43	154	174	195	227	250	0.11
AL-17230-F	46.5	0.795	+14	44	149	172	198	234	253	0.16
AL-17231-F	49.5	0.781	+21	38	145	165	186	221	246	0.08
AL-17259-F	46.3	0.796	+30	39	144	171	194	225	247	0.08

TABLE 2. Selected Characteristics of DFSC Samples of JP-8 (Part 1) (Continued)

Lab Code	Gravity, °API, D 1298	Density, kg/L, D 1298	Color, D 156	Flash Point, °C, D 93	Distillation, D 86					Sulfur, mass%, D 4294
					IBT	10%	50%	90%	EP	
AL-17260-F	48.8	0.785	+30	41	148	168	190	224	248	0.08
AL-17409-F	47.4	0.791	+30	39	148	172	196	226	242	0.05
AL-17425-F	46.4	0.795	+10	43	155	174	197	231	252	0.09
AL-17426-F	45.4	0.800	+2	41	151	173	201	238	255	0.12
AL-17493-F	45.3	0.800	+30	51	164	179	202	238	261	< 0.01
AL-17494-F	44.8	0.802	+30	50	162	179	203	239	266	< 0.01
AL-17495-F	44.9	0.802	+30	49	161	177	203	240	263	< 0.01
AL-17498-F	45.6	0.799	+30	51	163	178	202	238	268	< 0.01
AL-17505-F	49.5	0.781	+22	39	150	166	185	220	257	0.08
AL-17533-F	47.2	0.792	+12	45	161	177	192	216	241	0.06
AL-17534-F	46.5	0.795	+10	41	157	176	195	227	252	0.10
AL-17542-F	46.1	0.796	+30	45	155	177	200	227	231	0.02
AL-17591-F	43.9	0.806	+30	53	168	184	207	238	264	0.01
AL-17593-F	46.1	0.796	+17	39	155	174	202	237	256	0.14
AL-17594-F	46.4	0.795	+15	44	156	176	202	238	257	0.06
AL-17601-F	46.8	0.793	> +30	46	158	177	200	230	252	0.09
AL-17616-F	45.0	0.801	> +30	38	150	162	192	248	271	0.09
AL-17617-F	43.6	0.808	+17	44	160	177	208	252	276	0.13
AL-17618-F	40.8	0.821	+13	46	160	178	214	256	279	0.15
AL-17619-F	43.9	0.806	+18	43	153	171	205	250	274	0.18
AL-17623-F	44.9	0.802	> +30	53	168	183	206	238	258	< 0.01
AL-17624-F	45.8	0.798	> +30	51	167	179	201	234	254	< 0.01
AL-17625-F	43.7	0.807	> +30	49	160	178	207	242	262	< 0.01
AL-17627-F	49.3	0.782	+22	39	149	167	187	219	244	0.05
AL-17638-F	46.6	0.794	> +30	41	149	173	196	224	242	0.04
AL-17725-F	46.4	0.795	> +30	46	158	175	198	226	244	0.06
AL-17736-F	46.5	0.795	+15	43	154	172	200	237	254	0.15
AL-17737-F	46.2	0.796	+12	43	154	173	200	236	253	0.17
AL-17738-F	46.0	0.797	+6	41	152	172	201	236	254	0.16
AL-17767-F	49.0	0.784	+20	41	151	167	187	219	243	0.04
AL-17792-F	47.4	0.791	> +30	41	151	171	193	223	241	0.02
AL-17828-F	40.9	0.820	+12	52	166	187	216	249	269	0.04
AL-17829-F	42.4	0.813	+18	53	169	187	212	245	266	0.13
AL-17830-F	42.9	0.811	+18	53	170	188	212	244	264	0.28
AL-17835-F	44.7	0.807	+30	43	151	162	179	219	252	0.01
AL-17907-F	44.7	0.803	> +30	44	154	175	202	226	247	< 0.01
AL-17908-F	44.9	0.802	> +30	44	154	174	200	225	244	< 0.01
AL-18105-F	45.6	0.799	0	44	157	176	202	238	256	0.16
AL-18116-F	45.1	0.801	> +30	52	167	181	206	239	261	< 0.01
AL-18123-F	48.7	0.785	+23	39	150	167	188	222	243	0.04
AL-18133-F	40.8	0.821	+18	54	170	189	216	249	269	0.06
AL-18134-F	41.1	0.819	+19	57	174	191	216	247	266	0.07
AL-18144-F	46.0	0.797	+15	44	156	175	200	232	249	0.10
AL-18147-F	44.9	0.802	+30	52	163	179	204	237	254	< 0.01
AL-18157-F	45.5	0.799	+30	61	172	183	206	237	252	< 0.01

TABLE 2. Selected Characteristics of DFSC Samples of JP-8 (Part 2)

Lab Code	Cetane No., D 613	Cetane Index, D 976	F.V.E.* Cetane Index, D 4737	Kin Vis @ 40°C, cSt, D 445	Kin Vis @ 70°C, cSt, D 445	Heat of Combustion MJ/kg, D 240	Heat of Combustion Btu/lb, D 240	Heat of Combustion Btu/gal.,** D 240	Percent Aromatics, D 1319	Percent Olefins, D 1319	Percent Hydrogen, D 3178
AL-15050-F	42	45	46	1.39	0.95	43.034	18501	124771	18.6	1.6	13.8
AL-15854-F	44	45	47	1.24	0.86	43.005	18489	122638	15.0	1.7	14.1
AL-15996-F	45	45	47	1.21	0.89	42.829	18423	122207	12.6	0.1	14.0
AL-16025-F	46	45	47	1.23	0.86	43.047	18507	122905	14.0	0.1	14.0
AL-16064-F	44	43	44	1.37	0.92	42.985	18480	125054	15.5	3.5	13.5
AL-16091-F	40	41	42	1.41	0.95	42.810	18405	125338	13.0	1.5	13.6
AL-16234-F	43	44	46	1.25	0.88	42.838	18417	123062	19.0	1.0	13.8
AL-16236-F	42	42	43	1.42	0.96	42.882	18436	125254	17.0	1.0	13.8
AL-16242-F	42	46	45	1.58	1.06	42.775	18390	125383	20.8	1.4	13.6
AL-16253-F	48	48	50	1.27	0.88	43.112	18534	122658	16.5	<1.0	14.1
AL-16254-F	46	45	46	1.36	0.93	43.069	18516	124353	17.0	<1.0	13.8
AL-16255-F	46	47	49	1.29	0.90	43.168	18559	123325	16.0	<1.0	13.8
AL-16256-F	45	45	46	1.37	0.94	42.946	18463	124219	16.5	<1.0	14.2
AL-16418-F	52	48	50	1.36	0.94	42.992	18483	123300	16.0	2.0	14.0
AL-16449-F	47	47	49	1.32	0.92	43.075	18519	123262	15.1	<1.0	14.0
AL-16450-F	47	47	50	1.32	0.92	43.175	18562	123679	15.9	<1.0	13.9
AL-16466-F	47	46	47	1.23	0.82	42.868	18430	122596	18.9	1.1	13.8
AL-16536-F	47	47	48	1.29	0.90	43.118	18537	123382	16.5	<1.0	14.1
AL-16662-F	46	46	47	1.23	0.83	42.924	18454	122479	16.5	0.2	14.0
AL-16663-F	45	46	47	1.27	0.87	42.805	18403	122766	16.0	0.5	13.8
AL-16676-F	43	43	43	1.46	0.98	42.898	18443	125671	19.8	0.5	13.7
AL-16677-F	45	45	46	1.18	0.85	43.029	18499	122648	16.8	1.6	14.1
AL-16741-F	46	47	49	1.28	0.89	43.115	18536	122894	16.0	<1.0	14.1
AL-16742-F	45	46	48	1.28	0.89	43.110	18534	123158	16.5	<1.0	13.9
AL-16743-F	45	46	48	1.23	0.86	43.003	18488	122575	16.0	<1.0	14.1
AL-16770-F	45	45	48	1.14	0.81	42.998	18486	121730	17.5	0.5	14.1
AL-16771-F	46	47	49	1.20	0.84	42.901	18444	122007	15.0	0.2	14.0
AL-16844-F	43	44	46	1.14	0.81	43.035	18502	122187	17.8	1.0	13.6
AL-16965-F	43	44	46	1.16	0.82	43.069	18516	122483	15.7	1.2	13.9
AL-17034-F	45	47	49	1.13	0.80	43.006	18489	121621	17.3	1.7	13.8
AL-17042-F	45	46	47	1.28	0.89	43.118	18537	122270	18.9	1.7	13.9
AL-17087-F	42	42	43	1.31	0.91	42.925	18454	124804	14.7	1.7	13.5
AL-17102-F	42	42	44	1.11	0.79	43.040	18504	122608	18.8	0.3	13.7
AL-17107-F	42	41	44	1.06	0.75	42.994	18484	121717	18.6	0.1	13.8
AL-17114-F	46	46	48	1.17	0.83	43.138	18546	122329	17.2	1.8	14.0
AL-17115-F	4[illegible]	46	48	1.17	0.83	43.082	18522	122171	16.1	1.7	14.0
AL-17129-F	47	48	50	1.27	0.89	43.078	18520	122714	17.0	<1.0	13.9
AL-17130-F	47	47	49	1.26	0.88	43.131	18543	122996	16.5	<1.0	13.8
AL-17131-F	43	45	47	1.29	0.90	43.182	18565	123996	15.0	<1.0	13.8
AL-17132-F	45	47	48	1.27	0.89	43.273	18604	123679	15.9	0.8	13.9
AL-17186-F	45	45	49	1.05	0.75	43.082	18522	120689	12.6	0.2	14.1
AL-17215-F	43	45	47	1.14	0.81	42.784	18394	121474	18.7	0.9	13.8
AL-17220-F	40	40	41	1.30	0.90	42.775	18390	124868	20.5	1.4	13.4
AL-17228-F	44	45	45	1.24	0.87	42.880	18435	122832	14.8	0.2	13.8
AL-17229-F	44	44	46	1.21	0.85	43.082	18522	122727	16.5	0.6	14.0
AL-17230-F	44	46	48	1.23	0.86	43.115	18536	122671	17.5	1.4	13.8
AL-17231-F	48	46	49	1.09	0.78	43.054	18510	120482	12.4	0.3	14.1
AL-17259-F	44	44	46	1.16	0.83	42.861	18427	122097	18.9	1.1	13.7
AL-17260-F	46	47	49	1.13	0.81	43.115	18536	121114	13.5	0.2	14.0

* F.V.E. = Four Variable Equation.

** Btu/gal. is obtained by multiplying density in lb/gal. units by Btu/lb. API gravity is converted to lb/gal. using ASTM-IP Petroleum Measurement Tables.

TABLE 2. Selected Characteristics of DFSC Samples of JP-8 (Part 2) (Continued)

Lab Code	Cetane No., D 613	Cetane Index, D 976	F.V.E.* Cetane Index, D 4737	Kin Vis @ 40°C, cSt, D 445	Kin Vis @ 70°C, cSt, D 445	Heat of Combustion MJ/kg, D 240	Heat of Combustion Btu/lb, D 240	Heat of Combustion Btu/gal.,** D 240	Percent Aromatics, D 1319	Percent Olefins, D 1319	Percent Hydrogen, D 3178
AL-17409-F	45	47	49	1.16	0.83	43.098	18529	122013	16.4	0.7	13.8
AL-17425-F	44	45	47	1.22	0.86	43.114	18536	122745	14.8	1.1	13.9
AL-17426-F	44	45	47	1.24	0.87	42.960	18469	123004	17.4	1.5	13.7
AL-17493-F	47	45	47	1.28	0.89	43.110	18534	123492	17.0	<1.0	13.9
AL-17494-F	47	45	47	1.29	0.90	43.219	18581	124158	17.0	<1.0	13.8
AL-17495-F	46	45	47	1.29	0.90	43.089	18525	123728	15.5	<1.0	13.8
AL-17498-F	47	46	48	1.26	0.88	43.231	18586	123634	17.0	<1.0	13.8
AL-17505-F	48	46	49	1.09	0.78	43.129	18542	120690	11.5	0.3	14.3
AL-17533-F	46	45	47	1.15	0.82	43.224	18583	122499	13.9	1.5	13.8
AL-17534-F	45	45	47	1.19	0.84	43.031	18500	122433	14.2	1.5	14.1
AL-17542-F	44	46	48	1.21	0.85	43.057	18511	122783	16.5	0.6	13.7
AL-17591-F	45	45	46	1.32	0.92	42.971	18474	124071	17.5	<1.0	13.8
AL-17593-F	46	47	49	1.24	0.87	42.991	18483	122598	16.6	1.0	14.1
AL-17594-F	45	48	49	1.24	0.87	43.089	18525	122673	15.1	0.3	14.0
AL-17601-F	45	47	49	1.20	0.85	43.034	18501	122236	15.4	0.7	14.0
AL-17616-F	42	40	43	1.18	0.84	42.806	18403	122840	16.6	0.2	13.7
AL-17617-F	45	44	46	1.33	0.92	42.879	18435	124031	21.3	1.7	13.8
AL-17618-F	44	42	42	1.43	0.98	42.708	18361	125553	18.6	0.6	13.5
AL-17619-F	45	44	46	1.29	0.90	42.972	18474	124071	16.9	0.5	13.7
AL-17623-F	44	46	48	1.31	0.91	43.050	18508	123615	17.0	<1.0	13.9
AL-17624-F	45	46	48	1.25	0.87	42.888	18439	122527	17.0	<1.0	14.0
AL-17625-F	45	44	46	1.32	0.92	42.846	18421	123883	17.0	<1.0	13.2
AL-17627-F	45	46	49	1.10	0.78	43.110	18534	120768	12.0	0.3	14.4
AL-17638-F	46	45	47	1.16	0.82	43.011	18492	122325	20.4	<1.0	13.8
AL-17725-F	44	46	48	1.19	0.84	43.130	18543	122792	15.0	0.6	14.0
AL-17736-F	46	47	49	1.22	0.86	43.015	18493	122387	17.5	<1.0	14.1
AL-17737-F	46	46	48	1.23	0.86	42.978	18477	122502	17.8	<1.0	14.0
AL-17738-F	47	46	48	1.24	0.87	43.012	18492	122731	16.8	<1.0	14.0
AL-17767-F	47	46	49	1.09	0.78	43.212	18578	121240	12.7	0.3	14.2
AL-17792-F	44	46	48	1.13	0.80	43.117	18537	122066	19.9	0.7	13.9
AL-17828-F	45	43	43	1.50	1.02	42.920	18452	126100	18.4	2.0	13.7
AL-17829-F	41	44	45	1.44	0.98	42.962	18470	125134	19.8	1.8	13.7
AL-17830-F	47	45	46	1.43	0.98	43.010	18491	124925	18.9	1.5	13.8
AL-17835-F	38	34	37	1.08	0.78	42.999	18486	124299	17.2	1.0	13.7
AL-17907-F	44	44	45	1.23	0.86	43.068	18516	123798	18.4	0.3	13.8
AL-17908-F	45	44	45	1.21	0.85	42.986	18481	123435	19.6	0.3	13.8
AL-18105-F	46	46	48	1.27	0.88	43.026	18498	123049	17.0	2.1	14.0
AL-18116-F	46	46	48	1.32	0.92	43.005	18489	123340	17.0	<1.0	14.0
AL-18123-F	46	46	47	1.12	0.80	43.188	18567	121372	10.7	0.3	14.2
AL-18133-F	44	42	43	1.51	1.02	42.968	18473	126318	19.9	2.5	13.7
AL-18134-F	44	43	44	1.51	1.02	42.970	18473	126097	20.0	2.5	13.7
AL-18144-F	46	46	48	1.25	0.87	43.000	18487	122698	15.3	1.7	14.0
AL-18147-F	45	45	47	1.30	0.90	43.032	18500	123562	17.5	1.0	13.9
AL-18157-F	47	47	49	1.31	0.91	43.241	18590	123735	17.5	1.0	13.9

* F.V.E. = Four Variable Equation.

** Btu/gal. is obtained by multiplying density in Pb/gal. units by Btu/lb. API gravity is converted to Pb/gal. using ASTM-IP Petroleum Measurement Tables.

TABLE 3. Summary of JP-8 Characteristics

Properties	Partial Requirements				Data Summary			
	MIL-T-83133	VV-F-800D			Values			Standard Deviation (a)
	JP-8	DF-A	DF-1	NATO F-54	Average	Minimum	Maximum	
Gravity, °API, D 1298	37 to 51	(b)	(b)	(b)	45.4	40.8	49.5	2.00
Density, kg/L, D 1298	0.775 to 0.840	Report	Report	0.815 to 0.860	0.7995	0.781	0.821	0.0091
Flash Point, °C, D 93	38 min	38 min	38 min	56 min	45.6	36	61	5.2
Distillation, °C, D 86								
Initial Boiling Point	Report	(b)	(b)	(b)	157.5	144	174	7.4
10% Recovered	205 max	(b)	(b)	(b)	175.7	162	191	6.1
50% Recovered	Report	Report	Report	Report	200.1	179	222	7.9
90% Recovered	Report	288 max	288 max	357 max	235.3	216	256	9.5
End Point	300 max	300 max	330 max	370 max	257.8	231	297	11.5
Residue, vol%	1.5 max	3 max	3 max	3 max	0.8	0.5	1.0	0.25
Cetane Number, D 613	(b)	40 min	40 min	45 min	44.9	38	52	2.0
Cetane Index, D 976	Report	43 min	43 min	(b)	45.1	34	48	2.2
Four Variable Equation, Cetane Index, D 4737	(b)	(b)	(b)	(b)	46.8	37	50	2.3
Kinematic Viscosity at 40°C, cSt, D 445	(b)	1.1 to 2.4	1.3 to 2.9	1.3 to 5.0 (c)	1.25	1.05	1.58	0.11
Kinematic Viscosity at 70°C, cSt, D 445	(b)	(b)	(b)	(b)	0.88	0.75	1.06	0.061
Kinematic Viscosity at -20°C, cSt, D 445	8.0 max	(b)	(b)	(b)	4.09	2.7	6.5	0.709
Sulfur, wt%, D 4294	0.3 max	0.25 max	0.50 max	0.30 max	0.07	0.01	0.28	0.061
Net Heat of Combustion, D 240								
MJ/kg	42.8 min	(b)	(b)	(b)	43.019	42.708	43.273	0.1184
Btu/lb	18,400 min	(b)	(b)	(b)	18,495	18,361	18,604	50.9
Btu/gal.	(b)	(b)	(b)	(b)	123,138	120,482	126,318	1264.6
Aromatics, vol%, D 1319	25.0 max	(b)	(b)	(b)	16.70	10.7	21.3	2.12
Olefins, vol%, D 1319	5.0 max	(b)	(b)	(b)	1.02	0.1	3.5	0.60
Hydrogen, wt%, D 3701 (d)	13.4 min	(b)	(b)	(b)	13.88	13.4	14.4	0.19

(a) Based on formula using (n-1) as the divisor.
(b) No requirement.
(c) Equivalent to NATO F-54 kinematic viscosity requirement of 1.8 to 9.5 cSt at 20°C.
(d) Method for hydrogen at BFLRF was ASTM D 3178.

Many JP-8 samples were received from some refineries and only 1 or 2 from others. To compare the properties of the samples from each refinery, they were grouped according to their source, a few selected properties were averaged, and ranges of these properties were determined. These data are shown in TABLE 4. It is apparent that, in some cases, samples from the same refinery have virtually the same properties. However, in other cases, different batches from one refinery range widely in properties. From the data submitted with each sample, it was often difficult to determine if similar fuels were in fact from the same batches; therefore, no attempt to separate these potential duplications from the data base was made. Individual frequency histograms are presented in the discussion of each property in the following subsections. Frequency tabulations, which provide more detailed information for each property, are given in Appendix A.

The JP-8 sample properties reported by the suppliers are tabulated in Appendix B, TABLE B-1. These data are sorted according to source, and minimum, maximum, and average values for selected parameters are reported. Often the inspection report showed data from two or more tanks containing the product, and for a composite sample. When this occurred, TABLE B-1 shows multiple sets of data for one AL-code number.

1. Gravity and Density

The API gravities for the JP-8 fuels were in a rather narrow range as might be expected. A frequency histogram for this property is shown in Fig. 1. Densities of these fuels are also in a narrow range, and the distribution of values for this property is depicted in the frequency histogram in Fig. 2.

2. Flash Point

The flash points for the JP-8 fuels were found to be in a broad range. One sample had a flash point of 36°C, which is below the limit for JP-8, DF-A, and DF-1. The supplier, however, reported a value of 38°C. Fig. 3 is a frequency histogram of the flash point values for the JP-8 samples.

3. Distillation

The summarized distillation data in TABLE 3 show there is a variability in the boiling range for JP-8 samples from different sources. Figs. 4 through 8 show frequency

TABLE 4. Property Data for JP-8 Samples From Different Sources

Source	Sample Size	Gravity, °API			50% Distillation, °C			Cetane No.			Cetane Index			F.V.E.* Cetane Index		
		Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.
Athens, Greece	1	46.0	--**	--	200.0	--	--	46.0	--	--	46.0	--	--	48.0	--	--
Ft. Belvoir, Virginia	1	41.3	--	--	222.0	--	--	42.0	--	--	46.0	--	--	45.0	--	--
Britain	1	43.2	--	--	211.0	--	--	42.0	--	--	45.0	--	--	46.0	--	--
Castellon, Spain	3	43.2	42.0	45.0	200.7	192	206	41.3	40	42	40.7	40	42	42.3	41	43
Greece	1	46.1	--	--	198.0	--	--	44.0	--	--	45.0	--	--	47.0	--	--
Huelva, Spain	11	42.3	40.8	45.1	211.9	205	216	44.9	41	52	43.7	42	48	44.7	42	50
Killingholme, England	2	44.8	44.7	44.9	201.0	200	202	44.5	44	45	44.0	44	44	45.0	45	45
Norco, Louisiana	2	41.7	41.5	41.9	209.0	209	209	41.0	40	42	41.5	41	42	42.5	42	43
Pohang, Korea	2	46.8	46.3	47.4	186.0	183	189	42.0	42	42	41.5	41	42	44.0	44	44
Port Jerome, France	9	47.0	46.2	47.6	194.3	192	196	44.4	43	46	45.3	44	47	47.3	46	49
Priolo, Sicily	8	48.8	46.6	49.5	187.0	185	194	46.0	43	48	45.8	44	47	48.4	46	49
Rotterdam, Netherlands	26	45.3	43.6	46.5	203.5	199	212	45.9	43	48	46.1	44	48	47.9	46	50
Singapore	1	44.8	--	--	202.0	--	--	43.0	--	--	44.0	--	--	46.0	--	--
St. Theodori, Greece	21	46.2	45.1	47.2	199.0	192	203	45.5	44	47	44.0	44	48	47.5	45	49
West Germany	4	46.0	44.7	46.8	199.0	179	200	43.3	38	45	42.8	34	47	45.3	36	49

* Four Variable Equation.
**Min. and max. values not given when only one sample was received.

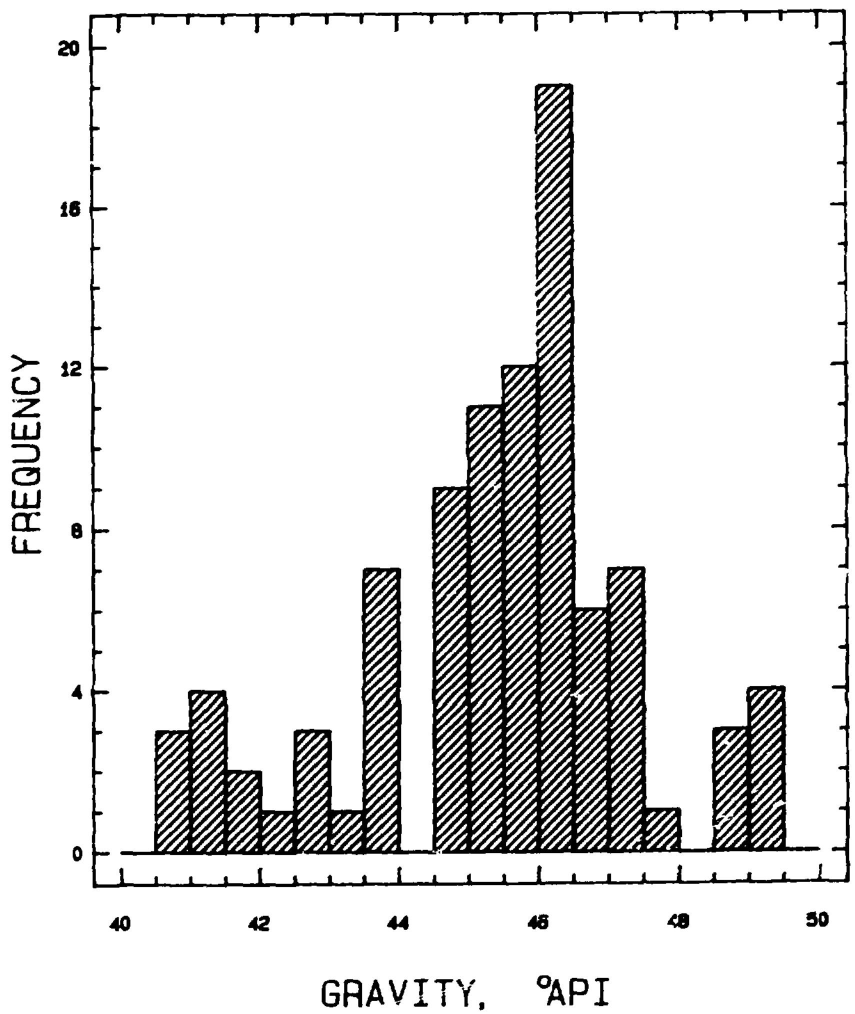

Figure 1. <u>Frequency histogram, JP-8, API gravity</u>

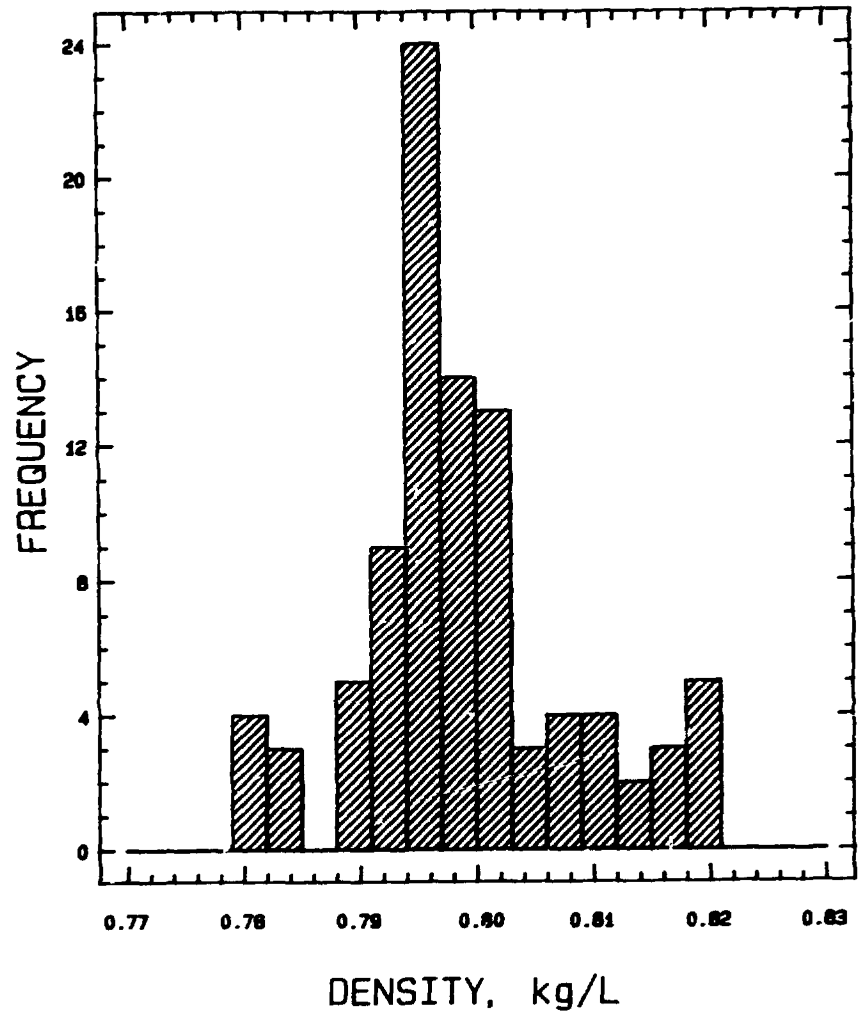

Figure 2. <u>Frequency histogram, JP-8, density</u>

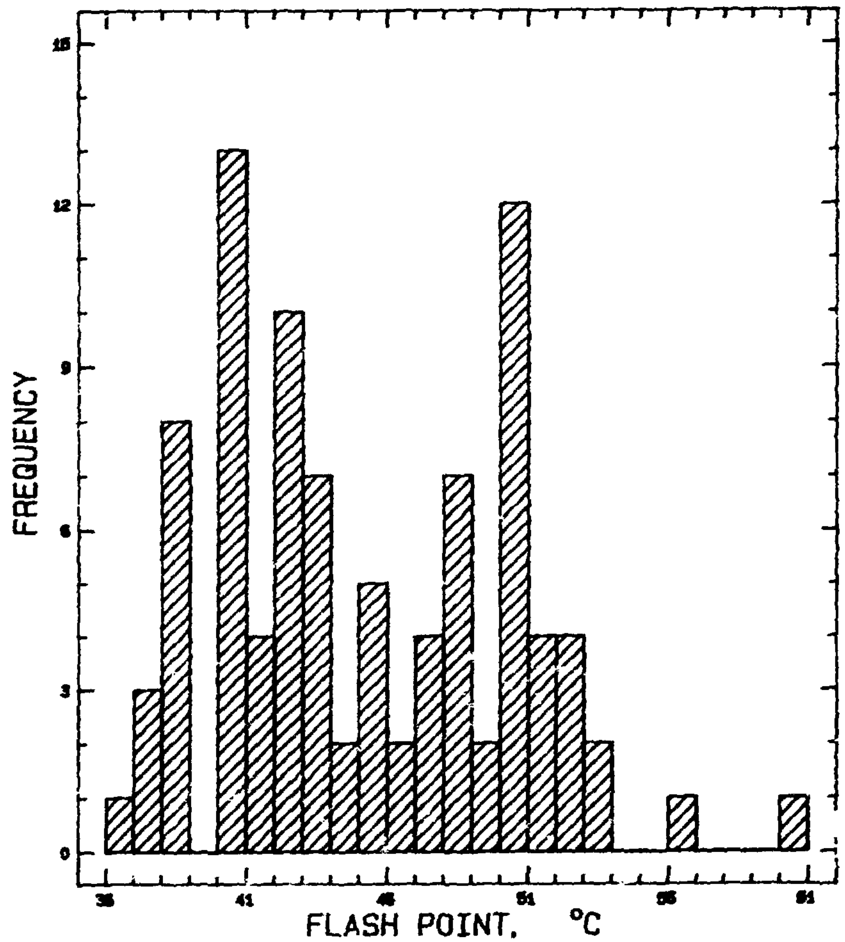

Figure 3. Frequency histogram, JP-8, flash point

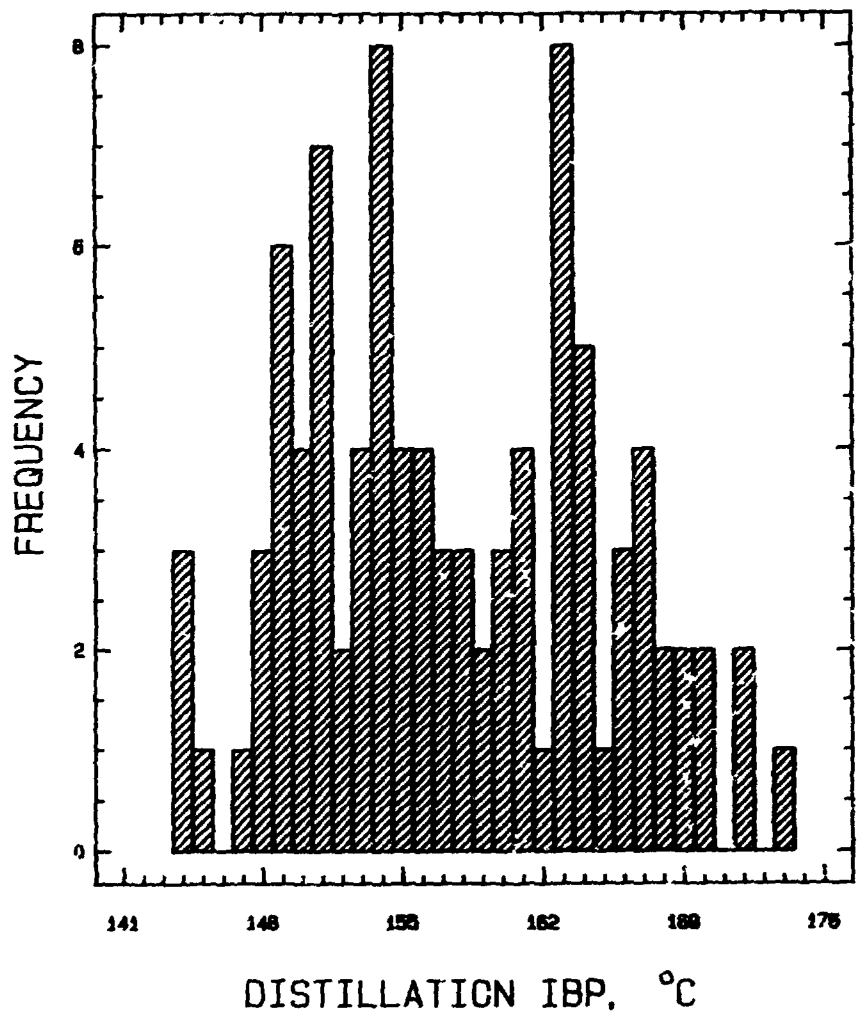

Figure 4. Frequency histogram, JP-8, distillation, initial boiling point

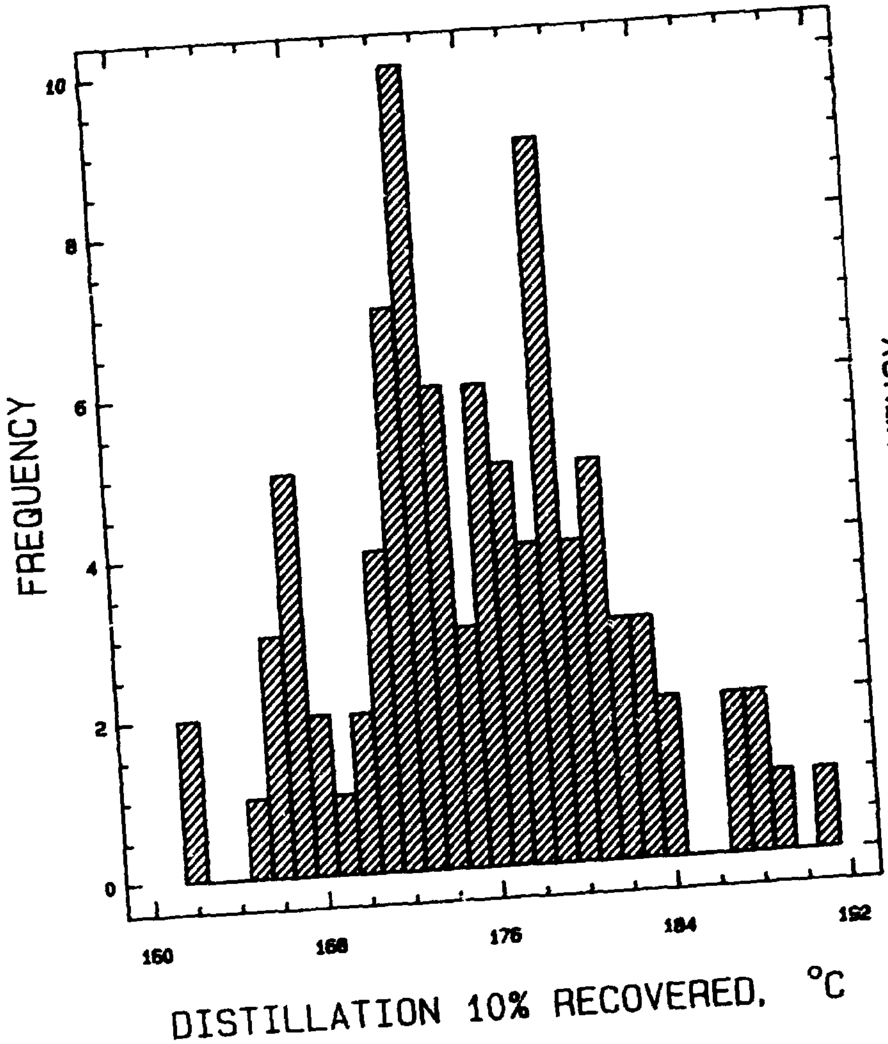

Figure 5. Frequency histogram, JP-8, distillation, 10-percent recovered

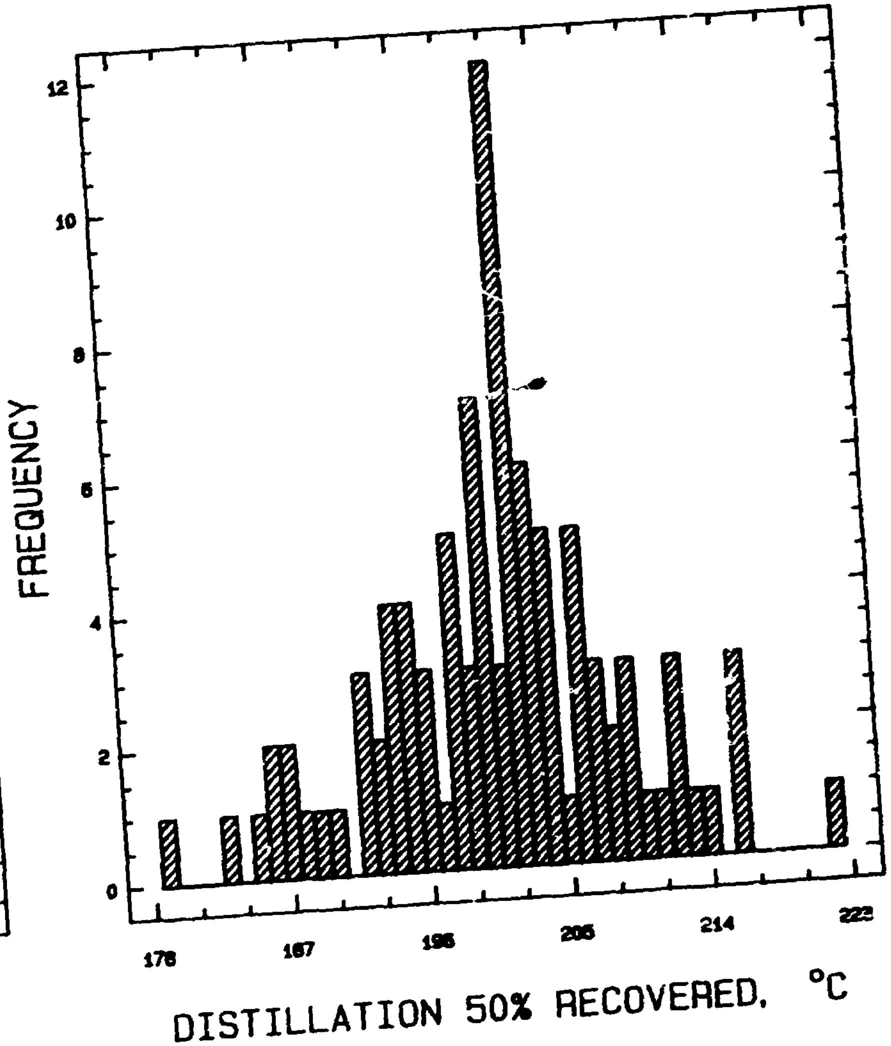

Figure 6. Frequency histogram, JP-8, distillation, 50-percent recovered

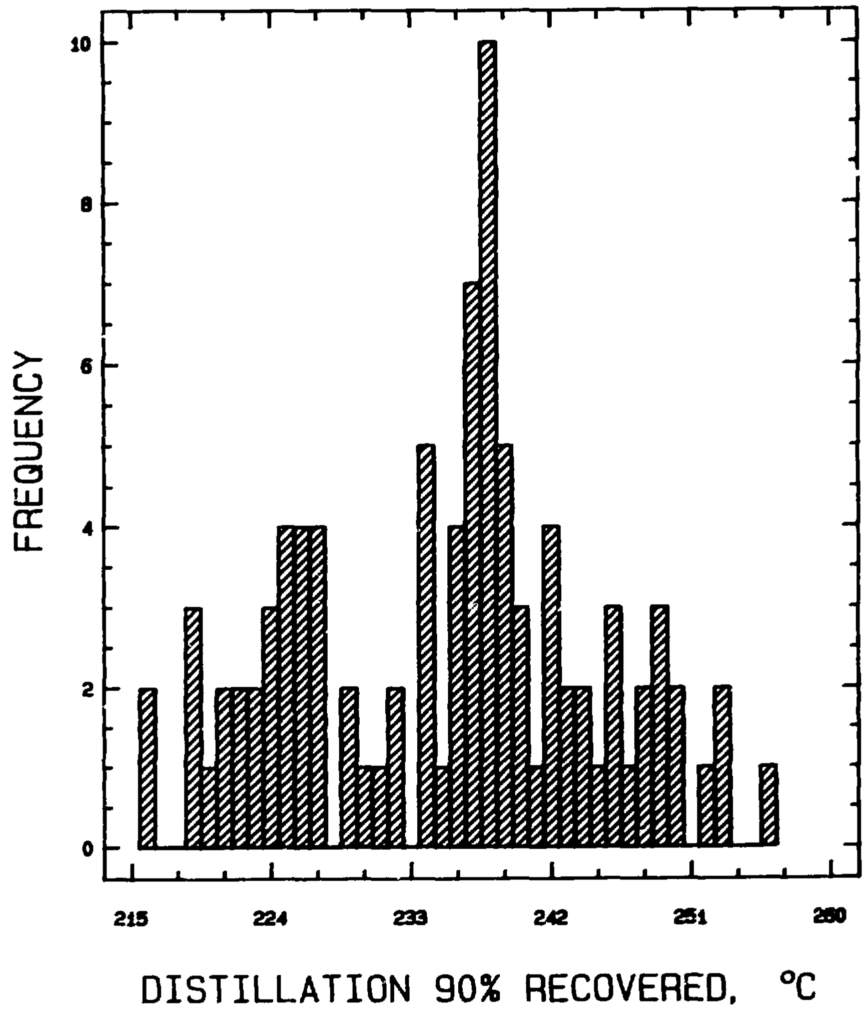

Figure 7. Frequency histogram, JP-8, distillation, 90-percent recovered

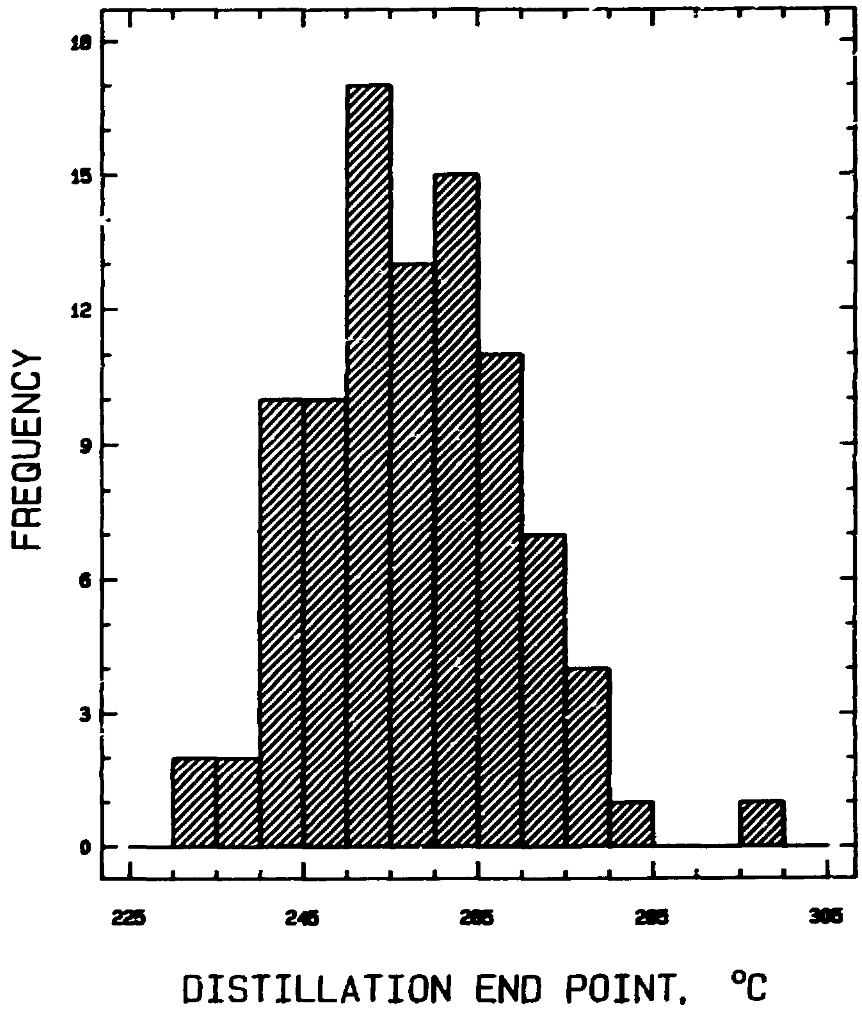

Figure 8. Frequency histogram, JP-8, distillation, end point

histograms for distillation temperatures at the initial boiling point (IBP), 10-, 50-, and 90-percent recovered, and end point, respectively.

4. Cetane Number and Cetane Index

All the JP-8 samples in this program had cetane numbers measured by ASTM D 613 of 40 and above, except for one sample that had a cetane number of 38. Fig. 9 is a frequency histogram showing the distribution of cetane number values among the JP-8 samples evaluated. Cetane indexes were calculated by two ASTM methods: D 976, "Calculated Cetane Index of Distillate Fuels," and D 4737, "Calculated Index by Four Variable Equation." To remain consistent with the VV-F-800D specification limits, all cetane number and cetane index values were rounded to the nearest integer. Actual values, reported to a tenth of a cetane number, are presented in Appendix C. The frequency histograms for these two properties are shown in Figs. 10 and 11, respectively. Linear regressions of cetane index, D 976, on cetane number, D 613, and four variable equation cetane index, D 4737, on cetane number, D 613, were performed and are plotted in Figs. 12 and 13, respectively. These plots show the lines of predictability at 95 percent confidence level and the ideal correlation lines. The correlation coefficient for D 976 on D 613 was found to be 0.75 and that for D 4737 on D 613 was 0.76, indicating that both equations have about the same level of predictability. It would be desirable to have a correlation with a better coefficient for predicting the ignition characteristics of JP-8 fuels; however, at the present time, these equations appear to be the best available. Since the cetane index, D 976, is easier to use, it is the recommended correlation.

Figs. 12 and 13 show what appears to be only 32 and 36 data points, respectively, and yet data for 93 fuels were used in these plots. The explanation is that many of those points represent data points for several fuel samples that had identical cetane number and cetane index values, Fig. 12, or cetane number and four variable equation cetane index values, Fig. 13.

5. Kinematic Viscosity

The kinematic viscosities of the JP-8 samples measured at 40°C ranged from 1.05 to 1.58 cSt, and six fuels were below the 1.1 minimum limit for DF-A. Three fuels measured 1.09, one was 1.08, one was 1.06, and the lowest was 1.05 cSt. The average value for 93 samples was 1.25 cSt. Fig. 14 is a frequency histogram depicting the

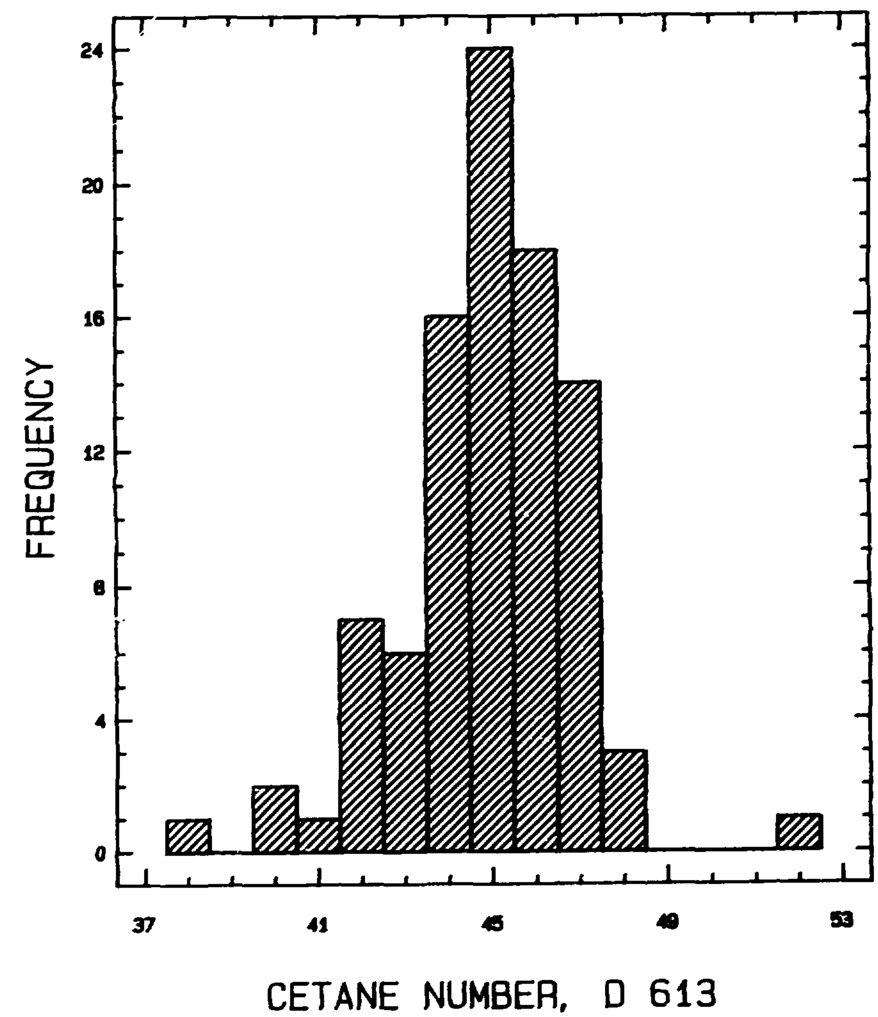

Figure 9. <u>Frequency histogram, JP-8, cetane number, D 613</u>

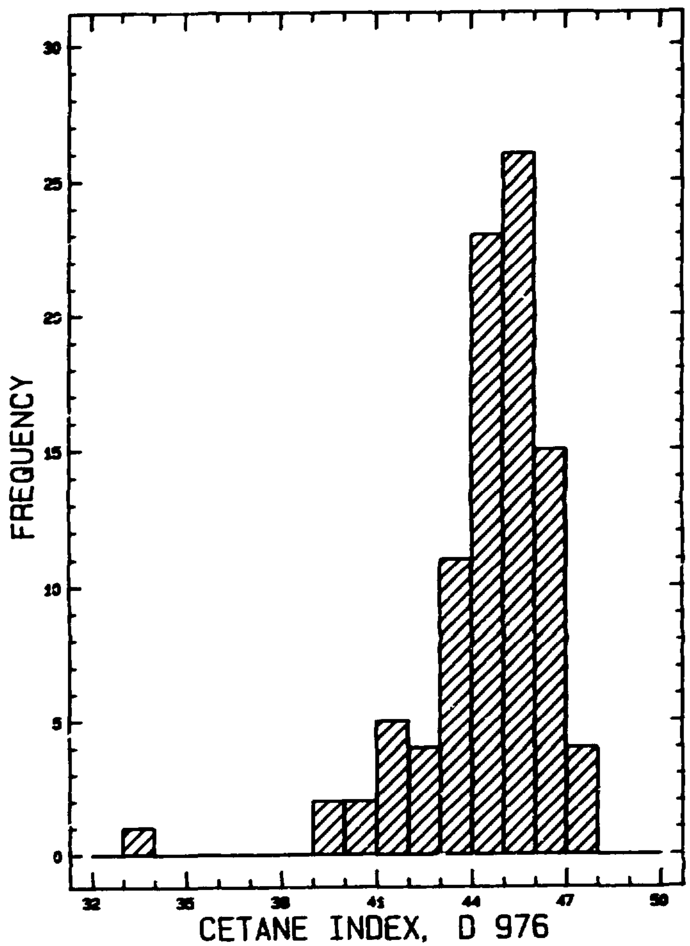

Figure 10. <u>Frequency histogram, JP-8, cetane index, D 976</u>

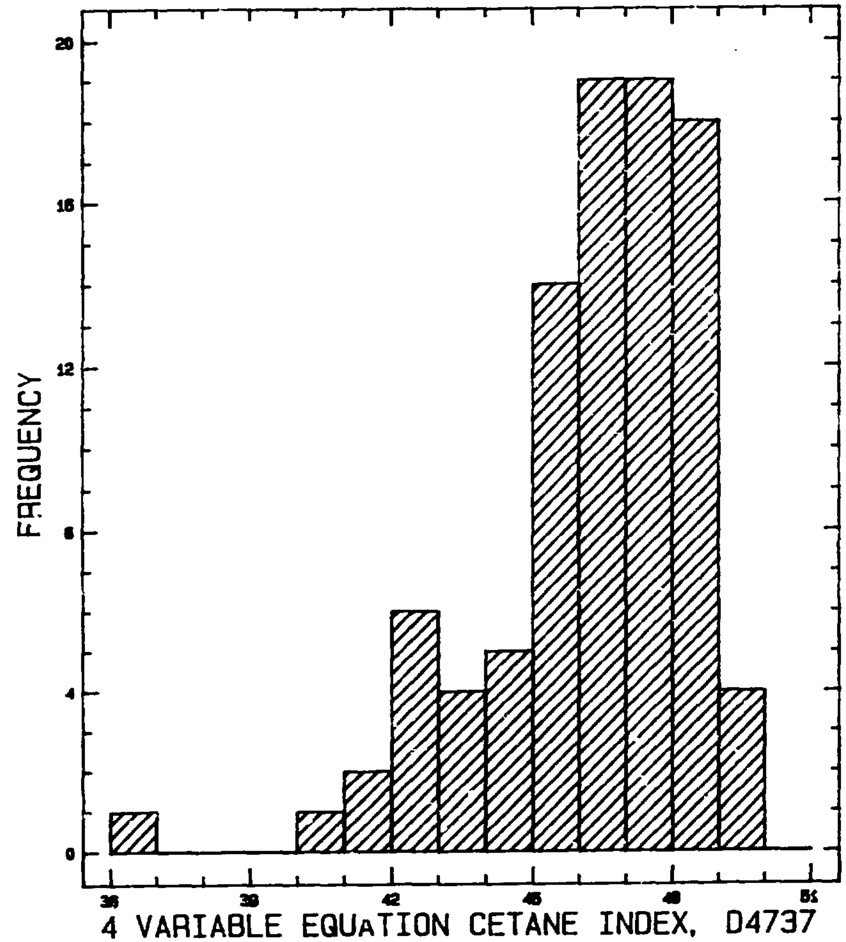

Figure 11. Frequency histogram, JP-8, four variable equation, cetane index, D 4737

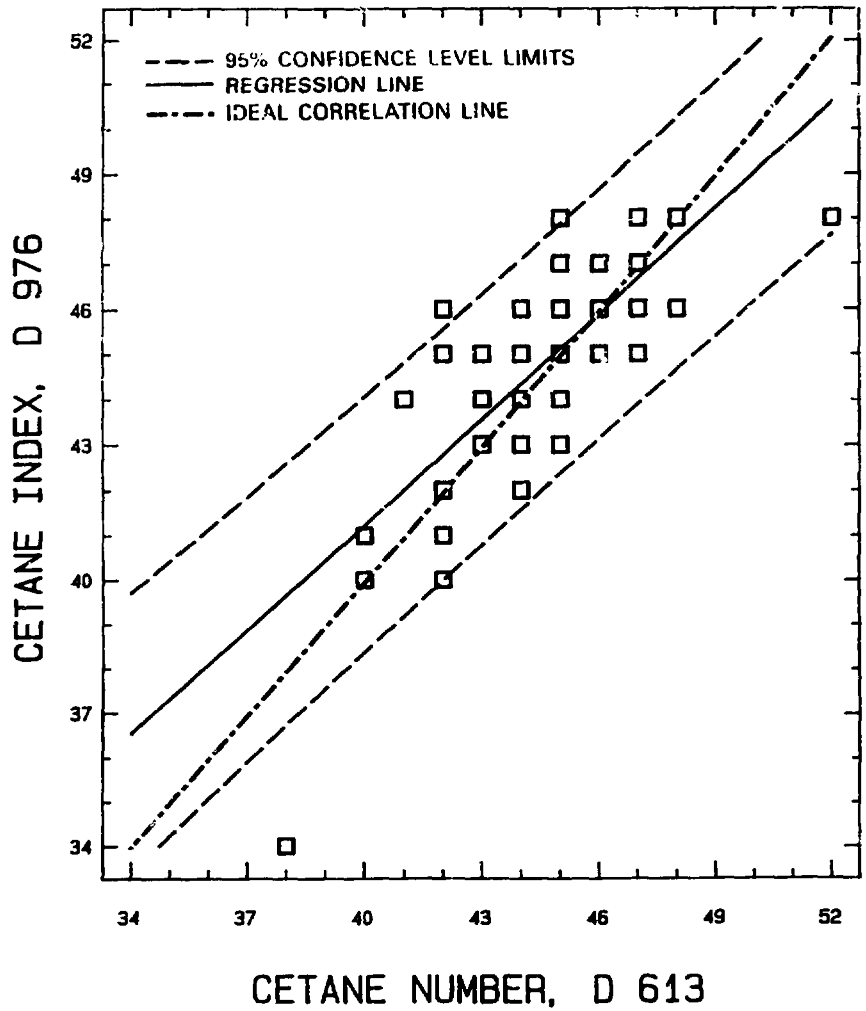

Figure 12. Regression of cetane index, D 976, on cetane number, D 613

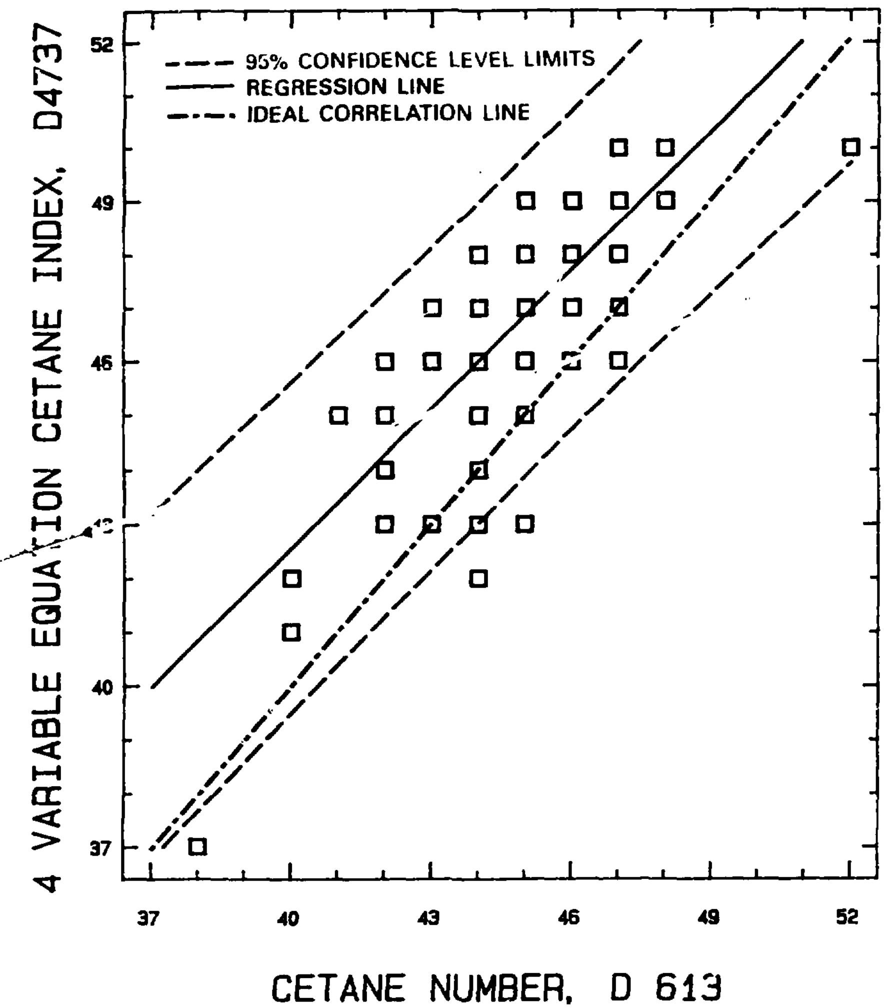

Figure 13. Regression of four variable equation cetane index, D 4737, on cetane number, D 613

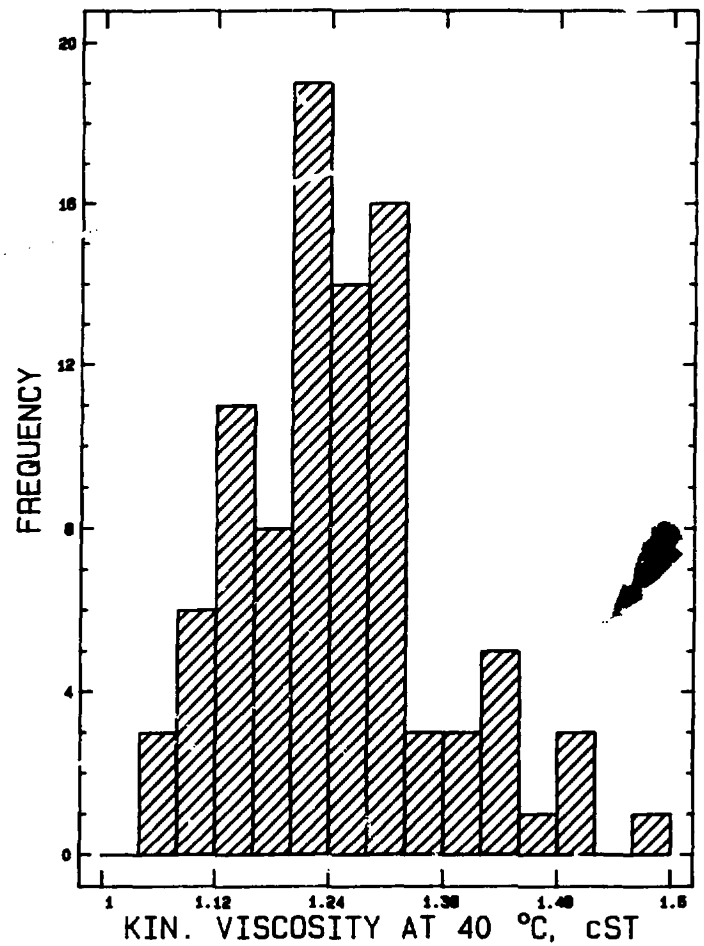

Figure 14. Frequency histogram, JP-8, kinematic viscosity at 40°C

distribution of these values. Kinematic viscosities measured at 70°C ranged from 0.75 to 1.06 cSt, and the average was 0.88 cSt. The distribution of the kinematic viscosities at 70°C values is shown in Fig. 15. The viscosities at -20°C, in most cases, were reported by the suppliers, but when these values were not reported, they were extrapolated from the values at 40° and 70°C. The extrapolated values at 100°C and -20°C were obtained using the mathematical relationships shown in Appendix X1 of ASTM Method D 341, "Viscosity Temperature Charts for Liquid Petroleum Products." Fig. 16 is a frequency histogram for kinematic viscosity at -20°C of the JP-8 sample. TABLE 5 lists the kinematic viscosities of the JP-8 samples at the three temperatures listed above plus estimated viscosities at 100°C. Viscosities at 70° and 100°C are not generally reported; however, in the testing program associated with the conversion from DF-2 to JP-8, it was of interest to know these properties. It has been estimated that under normal operating conditions, the fuel temperature in most diesel engines (that is, the temperature of fuel within the vehicle's tank) reaches 70°C (158°F). Also, in engine tests conducted at the U.S. Army Tank-Automotive Command, the temperature of the fuel entering the inlet to the fuel injector pump was heated to 91°C (195°F), perhaps the most extreme highest fuel temperature to be anticipated.

6. Sulfur Content

Determinations for sulfur content showed that the JP-8 fuels have a low average sulfur content. The distribution of this property is presented in the frequency histogram in Fig. 17, which shows a large number of these samples at 0.01 wt% sulfur.

7. Net Heat of Combustion

The net heat of combustion was determined for the 93 JP-8 samples and reported in three different units: MJ/kg, Btu/lb and Btu/gal. The distribution of the values for Btu/lb is shown in Fig. 18 and that for Btu/gal., in Fig. 19.

8. Aromatics and Olefins

Hydrocarbon-type analyses for the JP-8 samples were reported by the refiners, and frequency histograms for the aromatic and olefin content of these fuels are shown in Figs. 20 and 21, respectively.

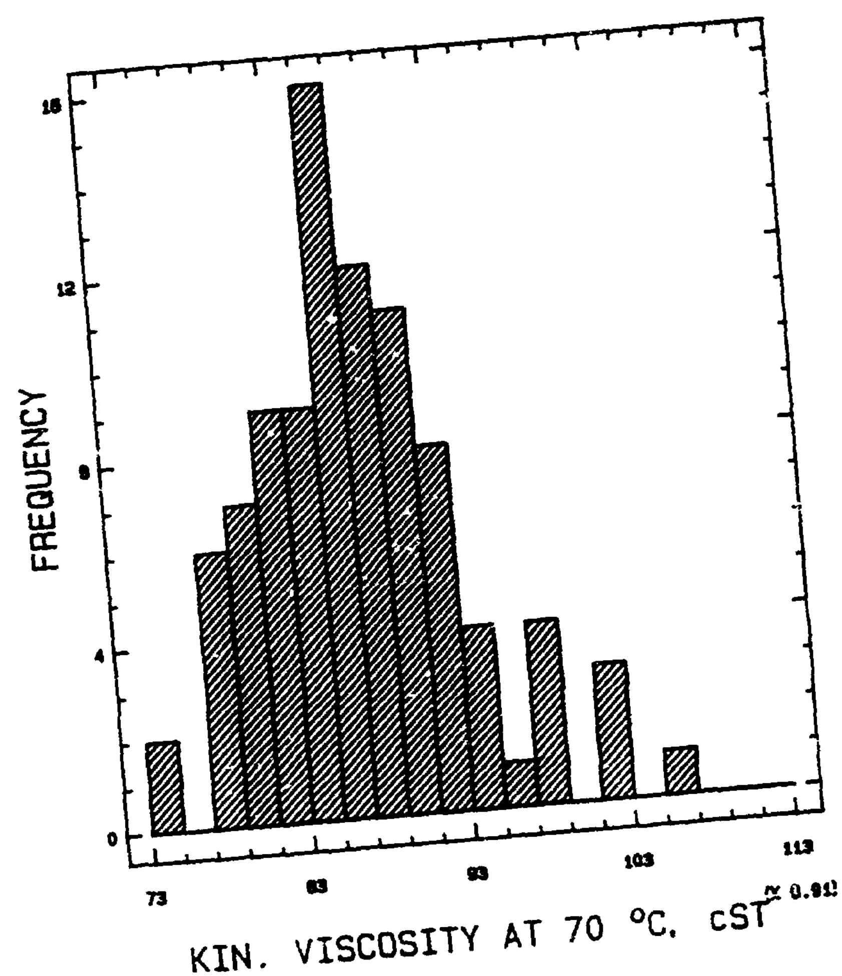

Figure 15. Frequency histogram, JP-8, kinematic viscosity at 70°C

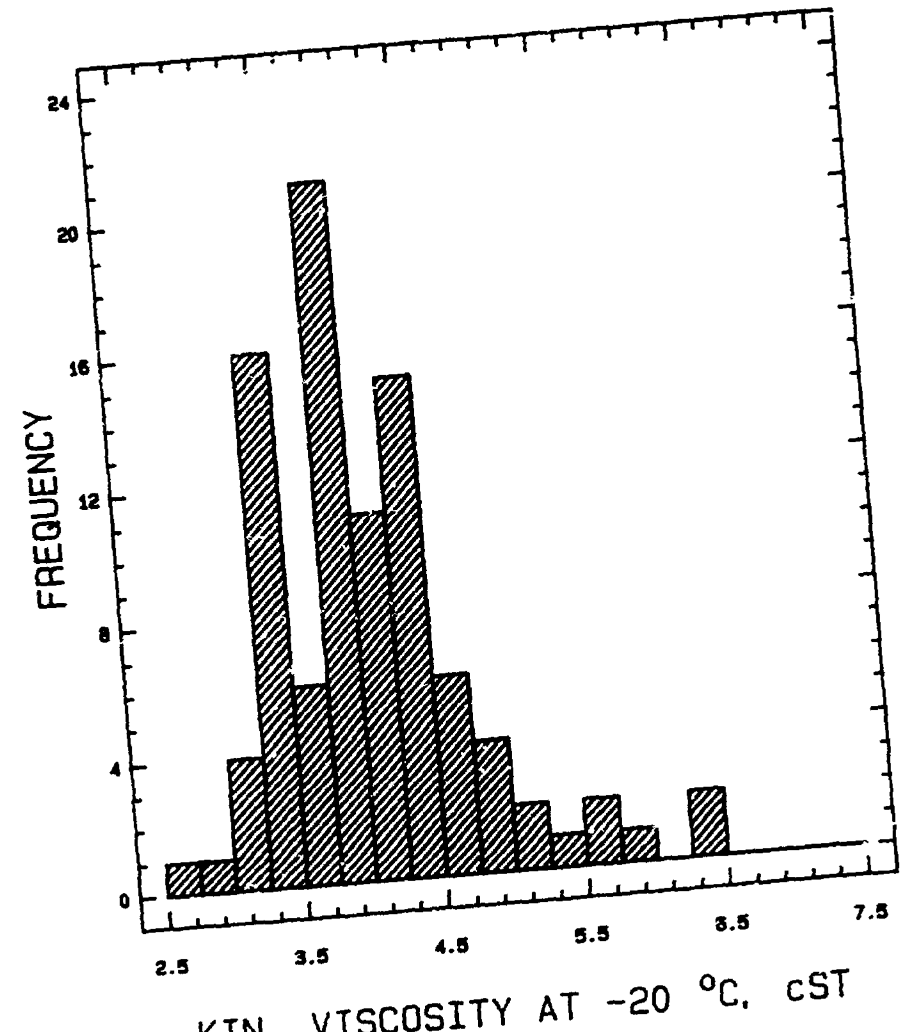

Figure 16. Frequency histogram, JP-8, kinematic viscosity at -20°C

TABLE 5. Kinematic Viscosities of JP-8 Samples

No.	AL-Code No.	Measured K Vis at 40°C (104°F)	Measured K Vis at 70°C (158°F)	Extrapolated K Vis at 100°C (212°F)	Extrapolated K Vis at -20°C (-4°F)	Reported K Vis at -20°C (-4°F)
1	15996	1.22	0.89	0.69	3.2	4.1
2	16025	1.23	0.86	0.64	3.8	4.2
3	16064	1.37	0.92	0.67	5.2	5.0
4	16091	1.41	0.95	0.69	5.3	5.3*
5	16234	1.25	0.88	0.66	3.8	4.0
6	16236	1.42	0.96	0.70	5.2	5.2*
7	16253	1.27	0.88	0.65	4.1	3.7
8	16254	1.36	0.93	0.68	4.7	4.4
9	16255	1.29	0.90	0.67	4.1	4.3
10	16256	1.37	0.94	0.69	4.7	4.8
11	16418	1.36	0.94	0.70	4.5	4.5*
12	16449	1.32	0.92	0.69	4.2	4.4
13	16450	1.32	0.92	0.69	4.2	4.6
14	16466	1.23	0.82	0.59	4.8	3.8
15	16536	1.29	0.90	0.67	4.1	4.1
16**						
17	16662	1.23	0.83	0.60	4.5	3.8
18	16663	1.27	0.87	0.64	4.4	3.8
19	16676	1.46	0.98	0.71	5.6	5.6*
20	16677	1.18	0.85	0.65	3.2	3.9
21	16741	1.28	0.89	0.66	4.1	4.3
22	16742	1.28	0.89	0.66	4.1	4.0
23	16743	1.23	0.86	0.64	3.8	4.3
24	16770	1.14	0.81	0.61	3.3	3.6
25	16771	1.20	0.84	0.63	3.7	3.9
26	16844	1.14	0.81	0.61	3.3	3.5
27	16965	1.16	0.82	0.62	3.4	3.4*
28	17034	1.13	0.80	0.60	3.3	3.5
29	17042	1.28	1.05	0.89	2.2	2.2*
30**						
31	17087	1.31	0.91	0.68	4.2	4.6
32	17114	1.17	0.83	0.63	3.4	3.4*
33	17115	1.17	0.83	0.63	3.4	3.4*
34	17129	1.27	0.89	0.67	3.9	4.4
35	17130	1.26	0.88	0.66	4.0	4.0
36	17131	1.29	0.90	0.67	4.1	4.2
37	17132	1.27	0.89	0.67	3.9	4.1
38	17186	1.05	0.75	0.57	2.9	3.3
39	17215	1.14	0.81	0.61	3.3	3.3*
40	17220	1.30	0.90	0.67	4.3	4.3*
41	17228	1.24	0.87	0.65	3.8	3.2
42	17229	1.21	0.85	0.64	3.7	3.2
43	17230	1.23	0.86	0.64	3.8	3.8*
44	17231	1.09	0.78	0.59	3.0	3.3
45	17259	1.16	0.83	0.63	3.3	3.3*

* Extrapolated values. Refiner did not report kinematic viscosity at -20°C.
** This sample was never received.

TABLE 5. Kinematic Viscosities of JP-8 Samples (Continued)

No.	AL-Code No.	Measured K Vis at 40°C (104°F)	Measured K Vis at 70°C (158°F)	Extrapolated K Vis at 100°C (212°F)	Extrapolated K Vis at -20°C (-4°F)	Reported K Vis at -20°C (-4°F)
46	17260	1.13	0.81	0.62	3.1	3.3
47	17409	1.16	0.83	0.63	3.3	3.6
48	17425	1.22	0.86	0.65	3.7	3.7*
49	17426	1.24	0.87	0.65	3.8	3.8*
50	17493	1.28	0.89	0.66	4.1	4.2
51	17494	1.29	0.90	0.67	4.1	4.3
52	17495	1.29	0.90	0.67	4.1	4.4
53	17498	1.26	0.88	0.66	4.0	3.9
54	17505	1.09	0.78	0.59	3.1	3.3
55	17533	1.15	0.82	0.62	3.3	2.7
56	17534	1.19	0.84	0.63	3.6	2.8
57	17542	1.21	0.85	0.64	3.7	3.9
58	17591	1.32	0.92	0.69	4.2	4.5
59	17593	1.24	0.87	0.65	3.8	3.8*
60	17594	1.24	0.87	0.65	3.8	3.1
61	17601	1.20	0.85	0.64	3.5	3.9
62	17616	1.18	0.84	0.64	3.4	3.7
63	17617	1.33	0.92	0.68	4.4	4.4*
64	17618	1.43	0.98	0.72	4.9	5.2
65	17619	1.29	0.90	0.67	4.1	4.6
66	17623	1.31	0.91	0.68	4.2	4.2
67	17624	1.25	0.87	0.65	4.0	3.9
68	17625	1.32	0.92	0.69	4.2	4.5
69	17627	1.10	0.78	0.59	3.2	3.3
70	17638	1.16	0.82	0.62	3.4	3.4*
71	17725	1.19	0.84	0.63	3.6	3.9
72	17736	1.22	0.86	0.65	3.7	3.7*
73	17737	1.23	0.86	0.64	3.8	3.8*
74	17738	1.24	0.87	0.65	3.8	3.8*
75	17767	1.09	0.78	0.59	3.0	3.3
76	17792	1.13	0.80	0.60	3.3	3.4
77	17828	1.50	1.02	0.75	5.4	5.4*
78	17829	1.44	0.98	0.72	5.1	5.1*
79	17830	1.43	0.98	0.72	4.9	4.9*
80	17835	1.08	0.78	0.60	2.9	3.4
81	17907	1.23	0.86	0.64	3.8	3.9
82	17908	1.21	0.85	0.64	3.7	4.0
83	18105	1.27	0.88	0.65	4.1	4.1*
84	18116	1.32	0.92	0.69	4.2	4.4
85	18123	1.12	0.80	0.61	3.2	3.3
86	18133	1.51	1.02	0.75	5.6	5.6*
87	18134	1.51	1.02	0.75	5.6	5.6*
88	18144	1.25	0.87	0.65	4.0	4.0*
89	18147	1.30	0.90	0.67	4.3	4.4
90	18157	1.31	0.91	0.68	4.2	4.4

* Extrapolated values. Refiner did not report kinematic viscosity at -20°C.

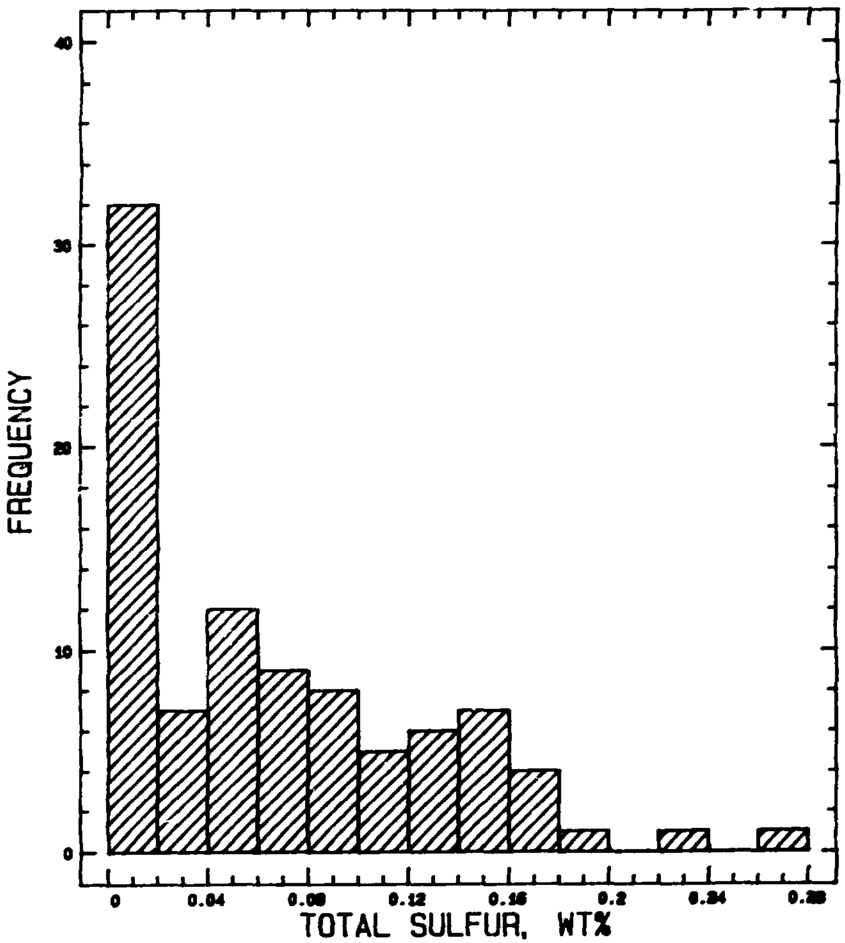

Figure 17. Frequency histogram, JP-8, sulfur content

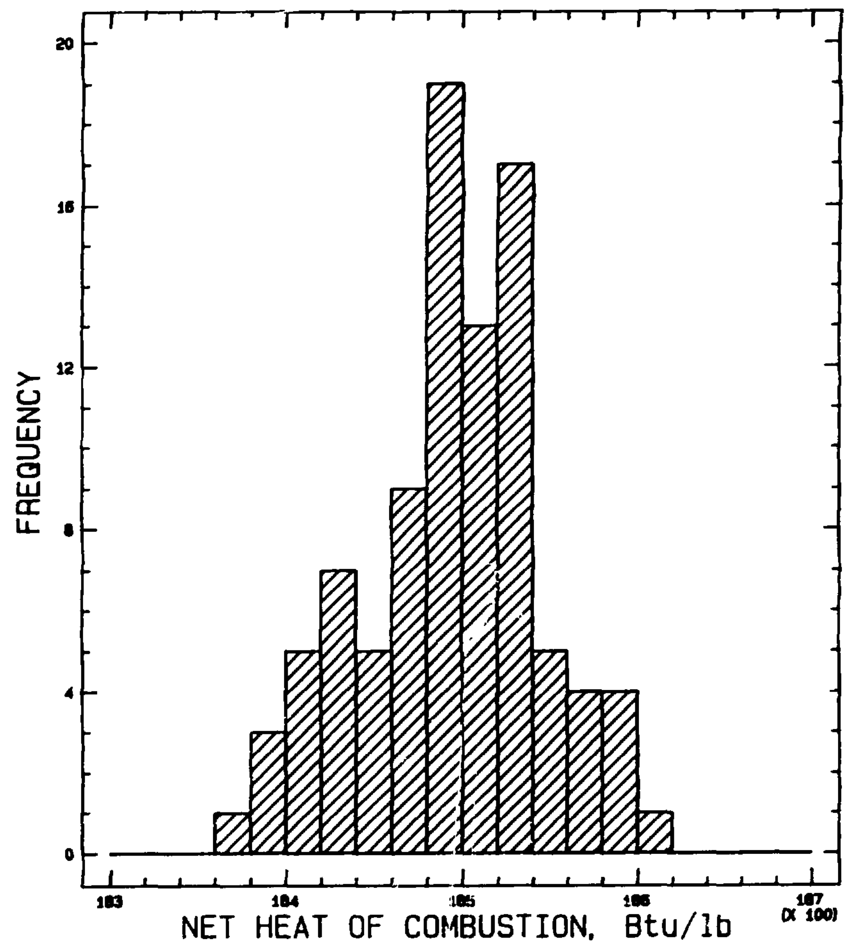

Figure 18. Frequency histogram, JP-8, net heat of combustion, Btu/lb

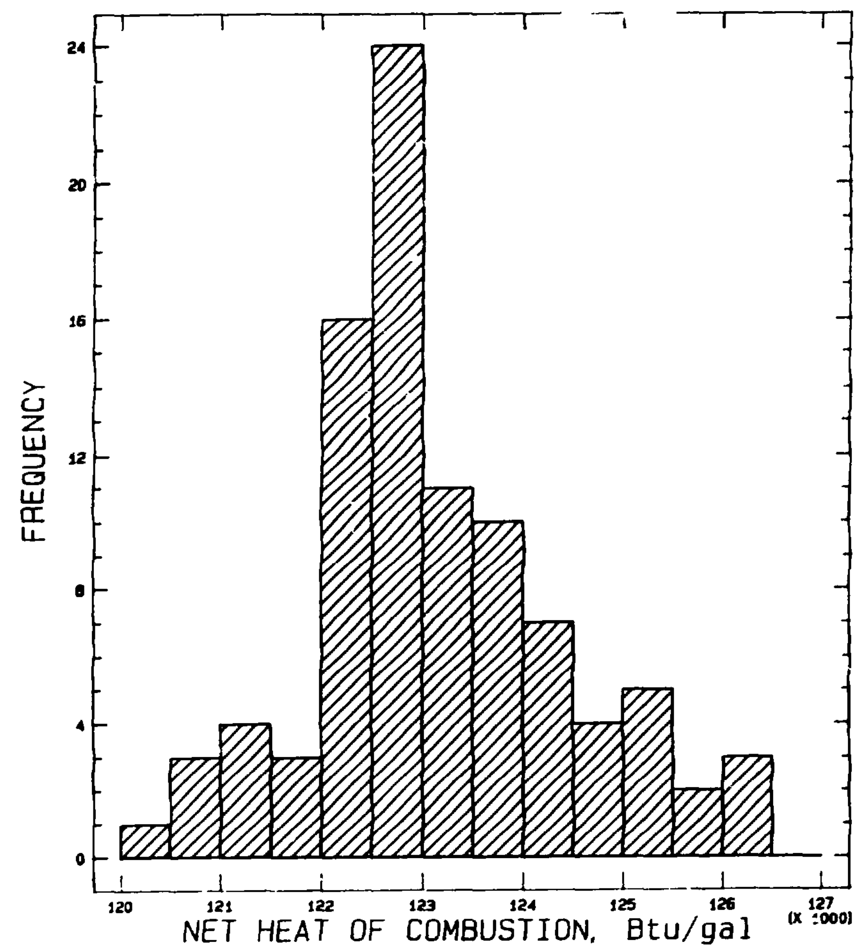

Figure 19. __Frequency histogram, JP-8, net heat of combustion, Btu/gal.__

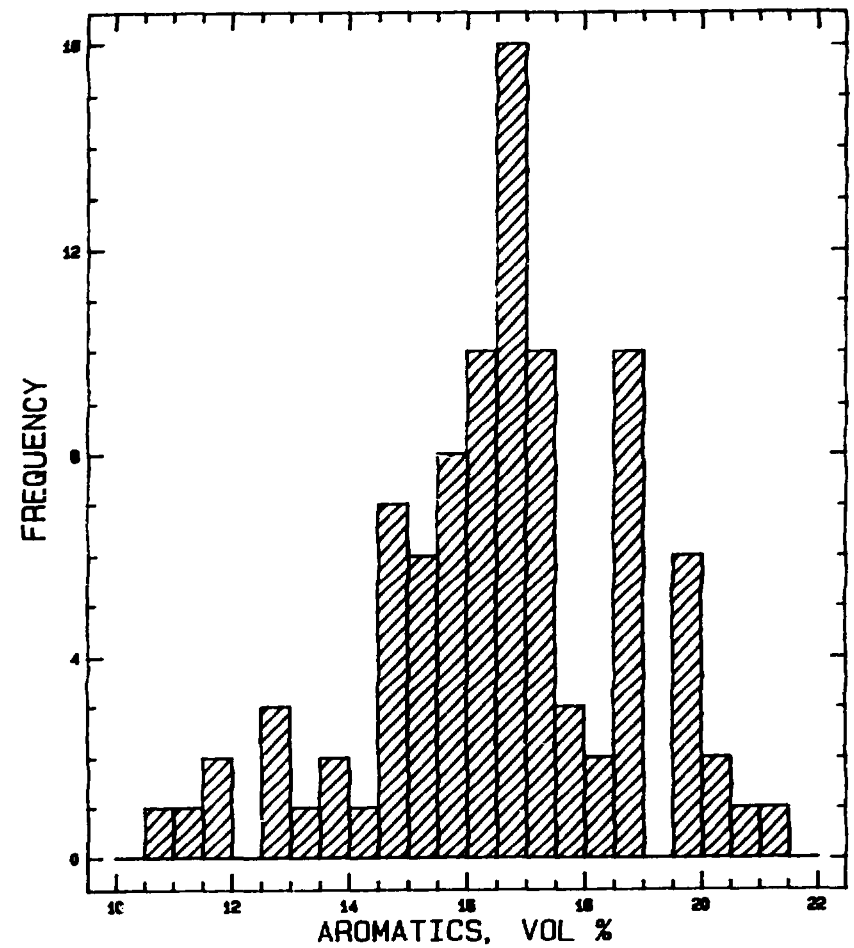

Figure 20. __Frequency histogram, JP-8, aromatics__

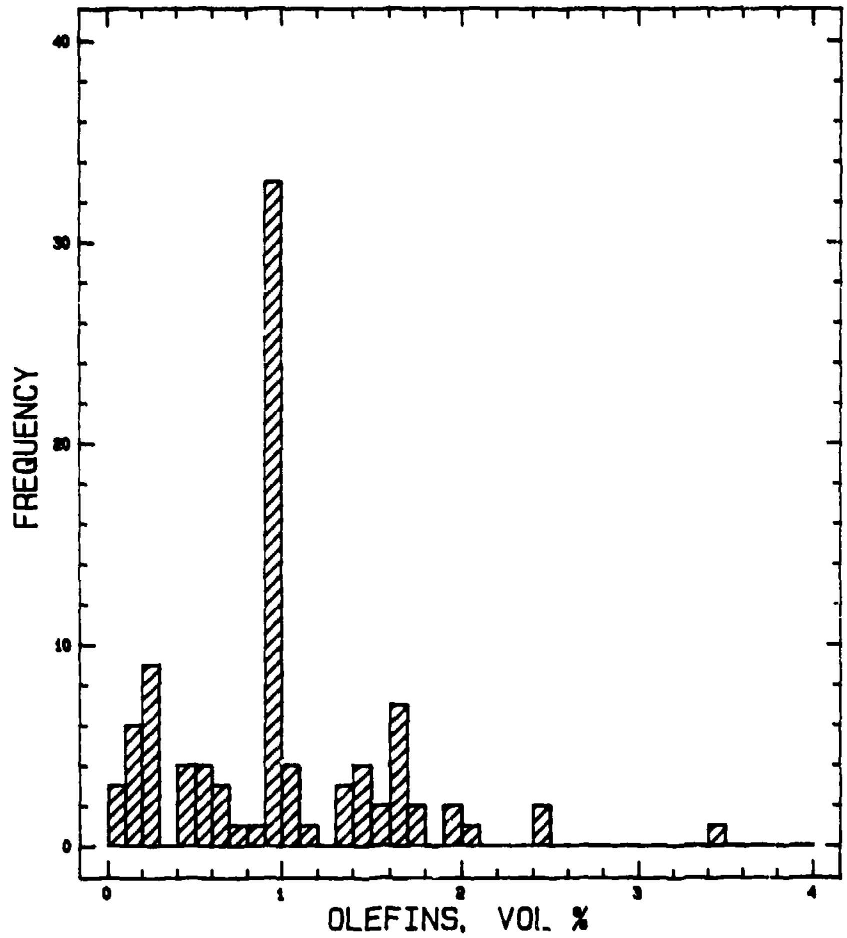

Figure 21. Frequency histogram, JP-8, olefins

9. Hydrogen Content

The hydrogen content of the JP-8 samples was determined to enable the calculation of the net heat of combustion from the measured gross heat of combustion by ASTM procedure D 240. A frequency histogram for this property is shown in Fig. 22.

B. Properties of JP-5 Samples Evaluated

During this program, 234 samples of JP-5 were received at BFLRF. Of these samples, 63 were evaluated for the same properties as the JP-8 samples. The remaining samples

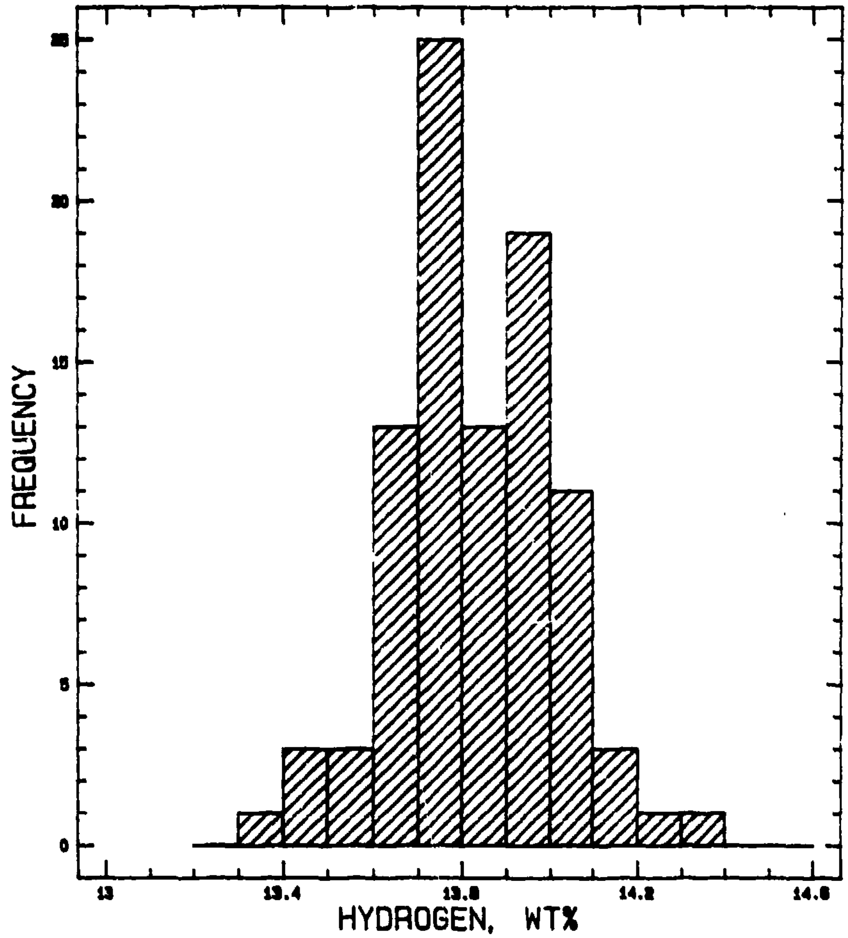

Figure 22. Frequency histogram, JP-8, hydrogen content

were evaluated for kinematic viscosities at 40° and 70°C only. The sources of these samples and the number of samples from each were:

Sample No.	Source	No. of Samples	Samples Evaluated
1	Deer Park, TX	34	10
2	Abilene, TX	23	5
3	Bakersfield, CA	12	2
4	Beaumont, TX	1	1
5	Corpus Christi, TX	14	5
6	Hanford, CA	2	2
7	Newhall, CA	62	19
8	Baton Rouge, LA	25	11
9	Ewa Beach, HI	1	1

Sample No.	Source	No. of Samples	Samples Evaluated
10	Sicily	15	2
11	Ferndale, WA	25	3
12	Three Rivers, TX	8	1
13	Pasadena, TX	1	1
14	Tacoma, WA	6	0
15	Torrance, CA	5	0

It is possible that samples from one refinery sampled on the same date came from one batch of fuel; however, they do represent different shipments. Since it was not clear that they were from the same batch, even though the inspection data may have been virtually identical, each sample was included in the statistical evaluation of the data.

TABLE 6 is a listing of the JP-5 samples evaluated, with identifying code numbers, refinery source, and sampling and receiving dates. In contrast with the JP-8 samples, most of the JP-5 fuels came from refineries in the U.S. Of the 63 samples, only 2 (both from Sicily) were provided by other than U.S. refineries. An additional 13 samples received from Sicily were evaluated only for viscosities. The data of special interest to this program are listed in TABLE 7, which consists of two parts. Part 1 of TABLE 7 contains the analytical properties measured primarily for comparison with the suppliers data. Part 2 contains the data more closely related to the utilization of JP-5 as a diesel fuel. The JP-5 analytical results are summarized and compared to partial requirements of MIL-T-5624M (grade JP-5) and VV-F-800D (grades DF-1 and NATO F-54) in TABLE 8.

As stated earlier, all except two of the 63 JP-5 samples came from refineries in the U.S., grouped in two general areas: the Pacific Coast and the Gulf Coast. In TABLE 9, a few properties for the samples received from each refinery are grouped and the averages, minimum, and maximum values are shown. It was observed that the JP-5 fuels from refineries supplying more than one sample had properties within a narrow range of values, in contrast with the JP-8 fuels from a single refinery that showed a broader range of values.

The JP-5 sample properties reported by the suppliers are shown in TABLE B-2 of Appendix B. These data are sorted according to source, and minimum, maximum, and average values for selected parameters are reported.

TABLE 6. Source of JP-5 Samples

Lab Code	Location	Sample Date	Date Received
AL-16775-F	Deer Park, Texas	10-15-87	10-19-87
AL-16792-F	Abilene, Texas	10-19-87	10-22-87
AL-16794-F	Bakersfield, California	10-08-87	10-26-87
AL-16795-F	Bakersfield, California	10-19-87	10-26-87
AL-16796-F	Deer Park, Texas	10-20-87	10-27-87
AL-16824-F	Deer Park, Texas	10-26-87	10-30-87
AL-16825-F	Beaumont, Texas	10-22-87	11-02-87
AL-16826-F	Corpus Christi, Texas	10-23-87	11-02-87
AL-16828-F	Hanford, California	10-14-87	11-09-87
AL-16829-F	Hanford, California	10-22-87	11-09-87
AL-16830-F	Newhall, California	10-26-87	11-09-87
AL-16831-F	Newhall, California	10-28-87	11-09-87
AL-16833-F	Abilene, Texas	11-05-87	11-11-87
AL-16834-F	Newhall, California	10-30-87	11-12-87
AL-16835-F	Newhall, California	11-02-87	11-12-87
AL-16836-F	Deer Park, Texas	11-06-87	11-12-87
AL-16841-F	Deer Park, Texas	11-09-87	11-16-87
AL-16842-F	Newhall, California	11-05-87	11-17-87
AL-16845-F	Baton Rouge, Louisiana	11-06-87	11-18-87
AL-16846-F	Ewa Beach, Hawaii	10-20-87	11-23-87
AL-16854-F	Corpus Christi, Texas	11-19-87	11-24-87
AL-16856-F	Newhall, California	11-06-87	11-25-87
AL-16857-F	Newhall, California	11-09-87	11-25-87
AL-16858-F	Newhall, California	11-09-87	11-25-87
AL-16859-F	Newhall, California	11-12-87	11-25-87
AL-16861-F	Deer Park, Texas	11-20-87	11-30-87
AL-16862-F	Newhall, California	11-16-87	11-30-87
AL-16863-F	Augusta, Sicily	11-03-87	11-30-87
AL-16864-F	Ferndale, Washington	11-10-87	11-30-87
AL-16865-F	Newhall, California	11-18-87	11-30-87
AL-16866-F	Corpus Christi, Texas	11-23-87	11-30-87
AL-16917-F	Baton Rouge, Louisiana	11-20-87	12-03-87
AL-16918-F	Abilene, Texas	11-20-87	12-01-87
AL-16919-F	Baton Rouge, Louisiana	11-17-87	12-03-87
AL-16958-F	Abilene, Texas	12-01-87	12-07-87
AL-16961-F	Newhall, California	11-20-87	12-08-87
AL-16962-F	Baton Rouge, Louisiana	11-27-87	12-09-87
AL-16963-F	Deer Park, Texas	12-03-87	12-09-87
AL-16964-F	Deer Park, Texas	12-06-87	12-09-87
AL-16969-F	Newhall, California	11-23-87	12-11-87
AL-16970-F	Newhall, California	11-30-87	12-11-87
AL-17043-F	Three Rivers, Texas	12-16-87	12-22-87
AL-17044-F	Newhall, California	12-08-87	12-22-87
AL-17047-F	Corpus Christi, Texas	12-18-87	12-23-87
AL-17055-F	Baton Rouge, Louisiana	12-08-87	12-28-87
AL-17057-F	Baton Rouge, Louisiana	12-08-87	12-28-87
AL-17058-F	Baton Rouge, Louisiana	12-08-87	12-28-87
AL-17059-F	Abilene, Texas	12-22-87	12-28-87
AL-17060-F	Ferndale, Washington	11-30-87	12-28-87
AL-17061-F	Ferndale, Washington	12-11-87	12-29-87
AL-17062-F	Baton Rouge, Louisiana	12-22-87	12-29-87
AL-17063-F	Baton Rouge, Louisiana	12-22-87	12-29-87
AL-17068-F	Newhall, California	12-11-87	01-04-88
AL-17069-F	Newhall, California	12-15-87	01-04-88
AL-17070-F	Newhall, California	12-21-87	01-04-88
AL-17071-F	Newhall, California	12-17-87	01-04-88
AL-17072-F	Deer Park, Texas	12-14-87	01-05-88
AL-17073-F	Deer Park, Texas	12-24-87	01-05-88
AL-17082-F	Pasadena, Texas	12-30-87	01-07-88
AL-17083-F	Baton Rouge, Louisiana	12-30-87	01-07-88
AL-17084-F	Baton Rouge, Louisiana	12-30-87	01-07-88
AL-17088-F	Corpus Christi, Texas	01-04-88	01-07-88
AL-17235-F	(Siracusa) Sicily	02-02-88	02-22-88

TABLE 7. Selected Characteristics of DFSC Samples of JP-5 (Part 1)

Lab Code	Gravity, °API, D 1298	Density, kg/L, D 1298	Color, D 156	Flash Point, °C, D 93	Distillation, D 86 IBT	10%	50%	90%	EP	Sulfur, mass%, D 4294
AL-16775-F	41.4	0.818	+30	67	185	199	216	241	265	0.01
AL-16792-F	43.1	0.810	+19	63	179	194	214	244	261	0.03
AL-16794-F	40.3	0.823	<-16	61	179	191	206	231	254	0.11
AL-16795-F	40.3	0.823	<-16	59	179	191	206	230	254	0.11
AL-16796-F	41.8	0.816	+30	65	183	197	221	242	260	0.01
AL-16824-F	41.8	0.816	>+30	68	189	200	217	241	259	0.04
AL-16825-F	42.1	0.819	+30	61	179	194	213	240	253	0.12
AL-16826-F	43.3	0.809	+30	54	180	194	211	236	255	0.15
AL-16828-F	40.0	0.825	<-16	60	182	192	205	224	244	0.12
AL-16829-F	39.7	0.826	<-16	63	186	196	208	228	247	0.12
AL-16830-F	38.9	0.830	<-16	60	178	194	214	243	263	0.25
AL-16831-F	38.5	0.832	<-16	62	179	196	217	247	266	0.26
AL-16834-F	38.4	0.832	<-16	62	181	198	219	249	271	0.27
AL-16833-F	43.3	0.809	+12	60	179	193	219	243	252	0.02
AL-16835-F	38.3	0.833	<-16	62	182	198	219	247	271	0.27
AL-16836-F	42.6	0.812	>+30	62	181	196	216	242	259	0.03
AL-16841-F	42.6	0.813	>+30	64	181	194	214	242	259	0.05
AL-16842-F	38.1	0.834	<-16	64	181	201	222	249	272	0.25
AL-16845-F	41.0	0.820	>+30	66	183	200	219	242	256	0.05
AL-16846-F	40.3	0.823	+21	62	178	194	217	243	256	0.06
AL-16854-F	45.2	0.800	>+30	53	174	189	207	237	256	0.02
AL-16856-F	38.0	0.834	-16	64	182	201	221	247	269	0.25
AL-16857-F	38.6	0.832	-16	60	176	194	217	245	267	0.23
AL-16858-F	38.3	0.833	-16	64	181	197	219	249	273	0.23
AL-16859-F	38.5	0.832	-16	62	178	195	218	247	270	0.24
AL-16861-F	42.9	0.811	>+30	64	[illegible]	193	212	244	259	0.01
AL-16862-F	38.4	0.832	<-16	64	181	197	218	245	266	0.24
AL-16863-F	45.2	0.800	>+30	61	173	188	203	223	243	0.03
AL-16864-F	41.4	0.818	+4	62	176	189	208	253	282	0.07
AL-16865-F	38.6	0.832	<-16	61	176	196	217	247	269	0.24
AL-16866-F	45.3	0.800	>+30	59	174	186	203	233	253	0.02
AL-16918-F	43.3	0.809	>+30	62	180	194	213	241	255	0.01
AL-16917-F	41.0	0.820	-16	66	184	200	218	242	267	0.06
AL-16919-F	40.5	0.822	+30	68	184	200	218	242	267	0.06
AL-16958-F	43.5	0.808	+17	59	183	194	214	242	259	0.01
AL-16961-F	38.5	0.832	-16	60	181	197	219	248	272	0.24
AL-16962-F	41.1	0.819	>+30	63	179	201	219	242	255	0.03
AL-16963-F	41.8	0.816	>+30	67	190	201	219	243	258	0.03
AL-16964-F	42.5	0.813	>+30	62	182	194	214	242	256	0.04
AL-16969-F	38.7	0.831	-16	62	178	198	218	245	266	0.25
AL-16970-F	38.7	0.831	-16	63	181	197	218	244	263	0.24
AL-17043-F	42.6	0.812	+21	61	177	192	211	241	261	0.04
AL-17044-F	38.6	0.831	<-16	62	181	195	216	244	264	0.23
AL-17047-F	45.6	0.799	>+30	59	177	189	206	233	256	0.03
AL-17055-F	40.9	0.820	>+30	66	186	203	219	243	258	0.06
AL-17057-F	41.0	0.820	>+30	65	186	203	220	242	257	0.06
AL-17058-F	41.2	0.819	>+30	63	183	201	219	243	259	0.06
AL-17059-F	43.4	0.809	>+30	58	178	193	214	246	265	0.07
AL-17060-F	41.3	0.819	+3	61	181	194	213	254	282	0.01
AL-17061-F	41.4	0.818	+6	61	180	193	213	257	284	0.01
AL-17062-F	41.3	0.819	>+30	62	185	202	222	246	262	0.05
AL-17063-F	41.2	0.819	>+30	63	183	201	219	243	258	0.05
AL-17068-F	38.6	0.832	<-16	61	179	197	219	249	270	0.27
AL-17069-F	39.3	0.828	<-16	58	177	192	214	242	262	0.24
AL-17070-F	39.2	0.829	<-16	60	177	193	214	243	265	0.24
AL-17071-F	38.9	0.830	<-16	60	178	195	217	247	269	0.25
AL-17072-F	42.3	0.814	>+30	62	178	193	214	242	261	0.01
AL-17073-F	41.8	0.816	>+30	68	186	200	217	239	257	0.04
AL-17082-F	42.4	0.813	+10	65	183	198	215	239	258	0.04
AL-17083-F	41.7	0.817	+27	63	181	200	219	242	258	0.05
AL-17084-F	41.6	0.817	+27	63	182	201	221	244	259	0.04
AL-17088-F	45.7	0.798	+30	59	177	189	206	233	253	0.01
AL-17235-F	45.9	0.797	+30	62	179	192	204	226	245	0.01

TABLE 7. Selected Characteristics of DFSC Samples of JP-5 (Part 2)

Lab Code	Cetane No., D 613	Cetane Index, D 976	F.V.E.* Cetane Index No., D 4737	Kin Vis @ 40°C, cSt, D 445	Kin Vis @ 70°C, cSt, D 445	Heat of Combustion MJ/kg, D 240	Heat of Combustion Btu/lb, D 240	Heat of Combustion Btu/gal,** D 240	Percent Aromatics, D 1319	Percent Olefins, D 1319	Percent Hydrogen, D 3173
AL-16773-F	43	43	45	1.53	1.03	42.991	18483	125943	[illegible]	0.7	13.7
AL-16792-F	44	46	47	1.47	0.99	43.040	18504	124865	15.9	1.1	13.9
AL-16794-F	38	38	39	1.39	0.95	42.757	18382	126064	20.5	1.0	13.4
AL-16795-F	38	38	39	1.39	0.95	42.745	18377	126029	19.3	1.1	13.4
AL-16796-F	41	44	47	1.48	1.01	43.001	18487	125675	18.8	0.8	13.7
AL-16824-F	43	45	46	1.52	1.02	43.029	18499	125756	18.0	2.0	13.6
AL-16825-F	44	44	43	1.46	0.99	42.938	18460	125270	20.5	0.5	13.8
AL-16826-F	44	45	47	1.41	0.96	43.015	18493	124643	23.1	0.3	13.7
AL-16828-F	38	37	37	1.37	0.94	42.724	18368	126188	21.3	0.8	13.5
AL-16829-F	39	38	38	1.42	0.97	42.777	18391	126567	22.4	0.8	13.5
AL-16830-F	38	39	39	1.52	1.02	42.710	18362	126955	15.8	0.8	13.3
AL-16831-F	39	38	39	1.58	1.05	42.770	18388	127429	14.8	0.9	13.3
AL-16833-F	47	46	49	1.60	1.07	42.691	18354	127285	17.5	1.1	13.8
AL-16834-F	39	40	40	1.47	0.99	43.126	18541	124966	16.6	0.8	13.4
AL-16835-F	40	39	39	1.60	1.06	42.708	18361	127407	15.7	0.7	13.3
AL-16836-F	42	46	47	1.47	0.99	43.004	18488	125108	19.4	0.6	13.6
AL-16841-F	44	45	46	1.46	0.99	43.022	18496	125162	19.2	0.4	13.9
AL-16842-F	39	40	40	1.65	1.09	42.694	18355	127512	16.7	0.9	13.4
AL-16845-F	44	44	44	1.55	1.04	43.026	18489	126341	18.2	1.4	13.7
AL-16846-F	44	42	42	1.48	1.01	42.843	18419	126318	22.9	1.1	13.5
AL-16854-F	44	47	49	1.33	0.93	43.210	18577	123853	19.3	0.2	13.9
AL-16856-F	38	39	40	1.66	1.11	42.714	18364	127648	16.2	1.1	13.3
AL-16857-F	38	39	39	1.57	1.05	42.717	18365	127196	17.7	1.0	13.6
AL-16858-F	38	39	40	1.64	1.09	42.696	18356	127372	17.7	1.0	13.4
AL-16859-F	39	39	39	1.60	1.07	42.696	18356	127207	15.3	0.9	13.4
AL-16861-F	45	45	46	1.45	0.99	43.098	18529	125182	18.9	0.6	13.8
AL-16862-F	39	39	39	1.60	1.08	42.740	18375	127431	14.4	0.7	13.3
AL-16863-F	44	46	47	1.29	0.90	43.105	18532	123553	18.8	0.3	13.9
AL-16864-F	41	41	43	1.47	1.01	42.983	18479	125916	18.5	0.5	13.5
AL-16865-F	39	39	39	1.58	1.06	42.724	18368	127217	18.7	0.5	13.1
AL-16866-F	44	46	48	1.32	0.91	43.200	18572	123745	19.0	0.5	13.9
AL-16917-F	46	44	44	1.47	1.00	43.131	18543	124980	19.2	0.9	13.6
AL-16918-F	45	46	47	1.56	1.05	43.024	18497	126335	16.0	1.8	13.8
AL-16919-F	44	43	44	1.61	1.07	42.988	18481	126595	19.3	0.7	13.5
AL-16958-F	46	47	48	1.46	0.99	43.097	18528	124730	16.6	1.6	14.0
AL-16961-F	38	39	42	1.59	1.05	42.695	18356	127207	16.8	0.8	13.4
AL-16962-F	43	44	45	1.56	1.04	43.034	18501	126288	17.5	1.0	13.6
AL-16963-F	45	45	46	1.55	1.04	43.091	18526	125940	19.3	0.6	13.8
AL-16964-F	43	45	46	1.44	0.97	43.004	18488	125182	19.2	0.6	13.7
AL-16969-F	39	40	40	1.57	1.05	42.614	18321	126818	17.3	0.8	13.3
AL-16970-F	38	39	40	1.56	1.04	42.738	18374	127185	16.8	1.0	13.4
AL-17043-F	45	44	45	1.42	0.97	42.977	18477	125034	17.9	0.5	13.7
AL-17044-F	39	39	39	1.54	1.03	42.780	18392	127383	16.5	0.6	13.3
AL-17047-F	47	47	49	1.30	0.89	43.201	18574	123554	17.9	2.2	13.9
AL-17055-F	46	44	45	1.58	1.06	42.940	18461	126162	16.7	1.3	13.5
AL-17057-F	45	44	45	1.61	1.06	43.059	18512	126437	16.7	1.3	13.7
AL-17058-F	45	45	45	1.58	1.08	42.973	18475	126036	16.9	1.2	13.7
AL-17059-F	47	47	48	1.47	1.00	43.087	18524	124778	16.4	1.3	13.8
AL-17060-F	41	42	44	1.49	1.01	42.915	18450	125792	21.4	0.5	13.7
AL-17061-F	41	42	44	1.50	1.01	43.054	18510	126127	21.8	0.6	13.6
AL-17062-F	47	45	46	1.60	1.07	43.110	18534	126365	15.6	0.4	13.7
AL-17063-F	45	45	45	1.59	1.06	43.061	18513	126296	16.2	0.5	13.6
AL-17068-F	39	40	40	1.60	1.07	42.753	18380	127300	18.1	1.2	13.3
AL-17069-F	38	39	40	1.49	1.01	42.716	18365	126682	15.4	0.9	13.4
AL-17070-F	39	39	39	1.51	1.02	42.706	18360	126721	15.2	2.5	13.4
AL-17071-F	39	40	40	1.54	1.04	42.779	18392	127162	16.0	1.0	13.4
AL-17072-F	43	44	45	1.44	0.98	43.019	18495	125378	20.7	2.1	13.7
AL-17073-F	43	45	46	1.52	1.03	43.021	18495	125729	20.7	2.3	13.7
AL-17082-F	44	45	46	1.48	1.01	43.084	18523	125493	18.8	0.4	13.8
AL-17083-F	47	45	46	1.56	1.05	42.950	18465	125599	16.3	1.1	13.8
AL-17084-F	47	46	46	1.58	1.06	43.061	18513	125599	15.6	0.7	13.7
AL-17088-F	48	48	50	1.34	0.92	43.091	18526	123161	17.4	0.3	14.0
AL-17235-F	44	47	49	1.35	0.93	43.252	18595	123489	10.7	0.2	[illegible]

* F.V.E. = Four Variable Equation.

** Btu/gal is obtained by multiplying density in Pb/gal units by Btu/lb. API gravity is converted to Pb/gal using ASTM-IP Petroleum Measurement Tables.

TABLE 8. Summary of JP-5 Characteristics

Properties	Partial Requirements			Data Summary			
	MIL-T-5624-M	VV-F-800D		Values			Standard Deviation (a)
	JP-5	DF-1	NATO F-54	Average	Minimum	Maximum	
Gravity, °API, D 1298	36.0 to 48.0	(b)	(b)	41.1	38.0	45.9	2.17
Density, kg/L, D 1298	0.788 to 0.845	Report	0.815 to 0.860	0.8194	0.797	0.834	0.0103
Flash Point, °C, D 93	60 min	38 min	56 min	62	53	68	2.9
Distillation, °C, D 86							
Initial Boiling Point	Report	(b)	(b)	180	173	243	3.4
10% Recovered	205 max	(b)	(b)	196	186	203	4.0
50% Recovered	Report	Report	Report	215	203	222	5.0
90% Recovered	Report	288 max	357 max	242	223	257	6.6
End Point	300 max	330 max	370 max	261	243	284	8.4
Residue, vol%	1.5 max	3 max	3 max	1	1	1	--
Cetane Number, D 613	(b)	40 min	45 min	42.3	38	48	3.2
Cetane Index, D 976	Report	43 min	(b)	42.7	37	48	3.2
Four Variable Equation, Cetane Index, D 4737	(b)	(b)	(b)	43.6	37	50	3.6
Kinematic Viscosity at 40°C, cSt, D 445	(b)	1.3 to 2.9	1.3 to 5.0 (c)	1.50	1.29	1.66	0.091
Kinematic Viscosity at 70°C, cSt, D 445	(b)	(b)	(b)	1.02	0.89	1.11	0.051
Kinematic Viscosity at -20°C, cSt, D 445	8.5 max	(b)	(b)	5.75	3.7	6.8	0.73
Sulfur, wt%, D 4294	0.40 max	0.50 max	0.30 max	0.11	0.01	0.27	0.097
Net Heat of Combustion, D 240							
MJ/kg	42.6 min	(b)	(b)	42.929	42.614	43.256	0.1715
Btu/lb	18,300 min	(b)	(b)	18,456	18,321	18,595	73.7
Btu/gal.	(b)	(b)	(b)	125,965	123,161	127,648	1140.4
Aromatics, vol%, D 1319	25.0 max	(b)	(b)	17.9	10.7	23.1	2.25
Olefins, vol%, D 1319	5.0 max	(b)	(b)	0.9	0.2	2.5	0.51
Hydrogen, wt%, D 3701 (d)	13.4 min	(b)	(b)	13.6	13.1	14.1	0.22

(a) Based on formula using (n-1) as divisor.
(b) No requirement.
(c) Equivalent to NATO F-54 kinematic viscosity requirement of 1.8 to 9.5 cSt at 20°C.
(d) Method for hydrogen at BFLRF was ASTM D 3178.

TABLE 9. Property Data for JP-5 Samples From Different Sources

Source	Sample Size	Gravity, °API			50% Distillation, °C			Cetane No.			Cetane Index			F.V.E.* Cetane Index		
		Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.
Siracusa, Sicily	1	45.9	--**	--	204.0	--	--	44.0	--	--	47.0	--	--	49.0	--	--
Abilene, Texas	5	43.3	41.3	45.5	214.8	213	219	45.8	44	47	46.4	46	47	47.8	47	49
Augusta, Sicily	1	45.2	--	--	203.0	--	--	44.0	--	--	46.0	--	--	47.0	--	--
Bakersfield, California	2	40.3	40.3	40.3	206.0	206	206	38.0	38	38	38.0	38	38	39.0	39	39
Baton Rouge, Louisiana	11	41.1	40.5	41.7	219.4	218	222	45.4	43	47	44.4	43	46	45.0	44	46
Beaumont, Texas	1	42.1	--	--	213.0	--	--	44.0	--	--	44.0	--	--	43.0	--	--
Corpus Christi, Texas	5	45.0	43.3	45.7	206.6	203	211	45.4	44	48	47.0	45	48	48.6	47	50
Deer Park, Texas	10	42.2	41.4	42.9	216.0	212	221	43.2	41	45	45.0	43	46	46.0	45	47
Ewa Beach, Hawaii	1	40.3	--	--	217.0	--	--	44.0	--	--	42.0	--	--	42.0	--	--
Ferndale, Washington	3	41.4	41.3	41.4	211.3	208	213	41.0	41	41	41.7	41	42	43.7	43	44
Hanford, California	2	39.8	39.7	40.0	206.5	205	208	38.5	38	39	37.5	37	38	37.5	37	38
Newhall, California	19	38.6	38.0	39.3	217.7	214	222	38.7	38	40	39.2	38	40	39.6	39	42
Pasadena, Texas	1	42.4	--	--	215.0	--	--	44.0	--	--	45.0	--	--	46.0	--	--
Three Rivers, Texas	1	42.6	--	--	211.0	--	--	45.0	--	--	44.0	--	--	45.0	--	--

* Four Variable Equation.
**Min. and max. values not given when only one sample was received.

1. Gravity and Density

The API gravity and density of the JP-5 samples fall into a narrow range of values as would be expected. Frequency histograms for these two properties are shown in Figs. 23 and 24.

2. Flash Point

The BFLRF data show nine samples with flash points below 60°C, the minimum requirement for JP-5. Five of these were at 59°C, two at 58°C, one at 54°C, and one at 53°C. The reported data from the refiners showed all the samples meeting the flash point requirement. A frequency histogram for the flash point values of JP-5 is shown in Fig. 25.

3. Distillation

The distillation data for JP-5 samples show that these fuels are in a more narrow boiling range than the JP-8 fuels, which would be expected due to the higher minimum flash point limit. Frequency histograms for the 10-, 50-, and 90-percent recovered distillation temperatures are shown in Figs. 26 through 28, respectively.

4. Cetane Number and Cetane Index

Twenty-two of the 63 samples of JP-5 analyzed had cetane numbers measured by D 613 below 40, twelve had values of 39, and ten had values of 38. All the samples with cetane numbers below 40 came from refineries in California. The lower cetane numbers for these fuels is probably due to the type crude used to produce them. Fig. 29 is a frequency histogram showing the distribution of cetane number values among the JP-5 samples evaluated. The cetane index for each of these samples was calculated by ASTM Methods D 976, "Calculated Cetane Index of Distillate Fuels," and D 4737, "Calculated Cetane Index by Four Variable Equation." To remain consistent with the VV-F-800D specification limits, all cetane number and cetane index values were rounded to the nearest integer. Actual values, reported to a tenth of a cetane number, are presented in Appendix C. Frequency histograms for these two properties are shown in Figs. 30 and 31. Linear regressions of cetane index, D 976, on cetane number, D 613, and four

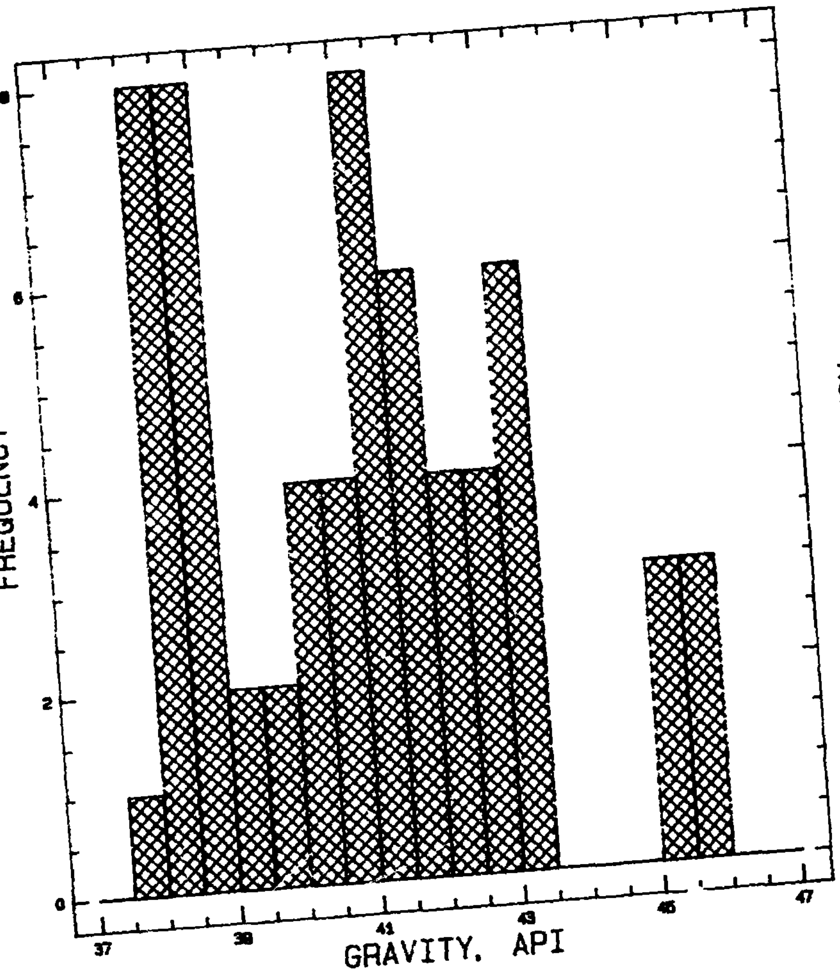

Figure 23. Frequency histogram, JP-5, API gravity

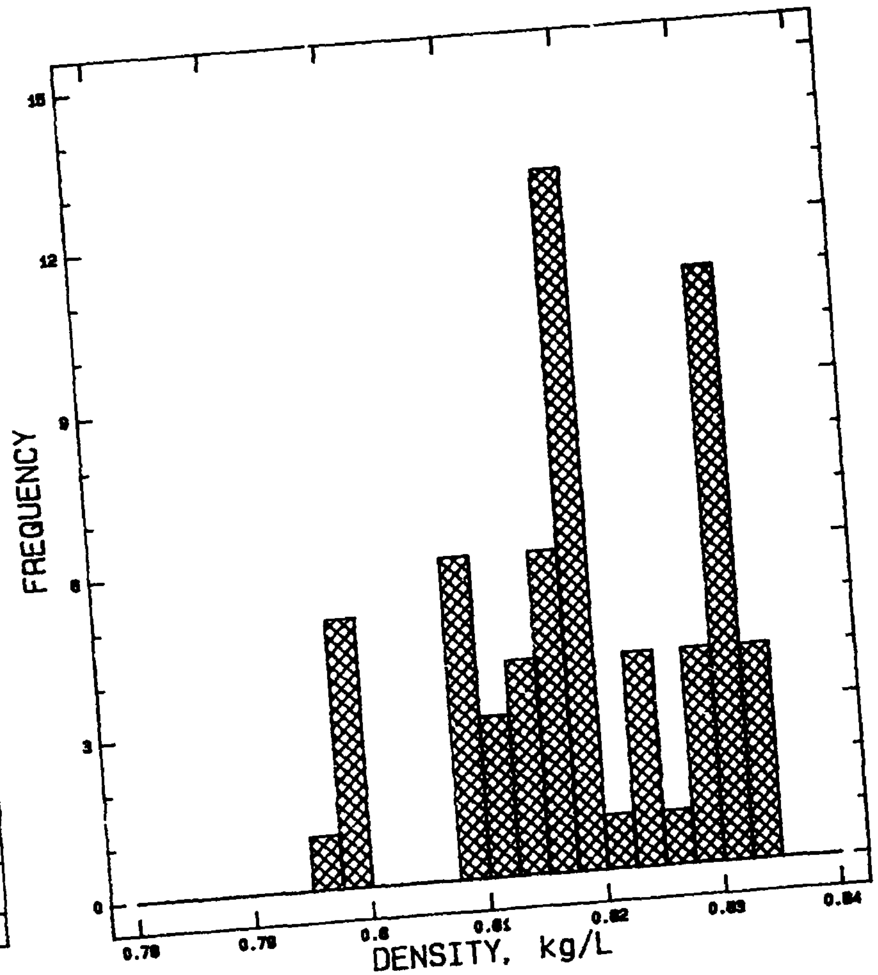

Figure 24. Frequency histogram, JP-5, density

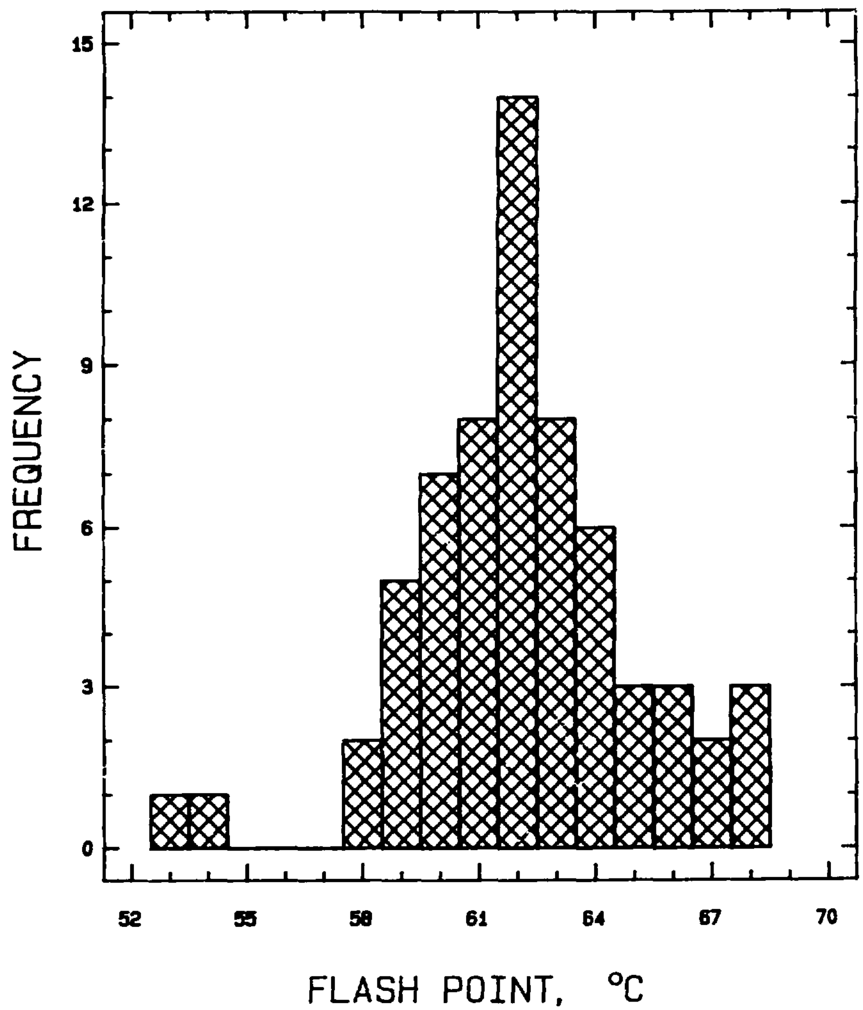

Figure 25. Frequency histogram, JP-5, flash point

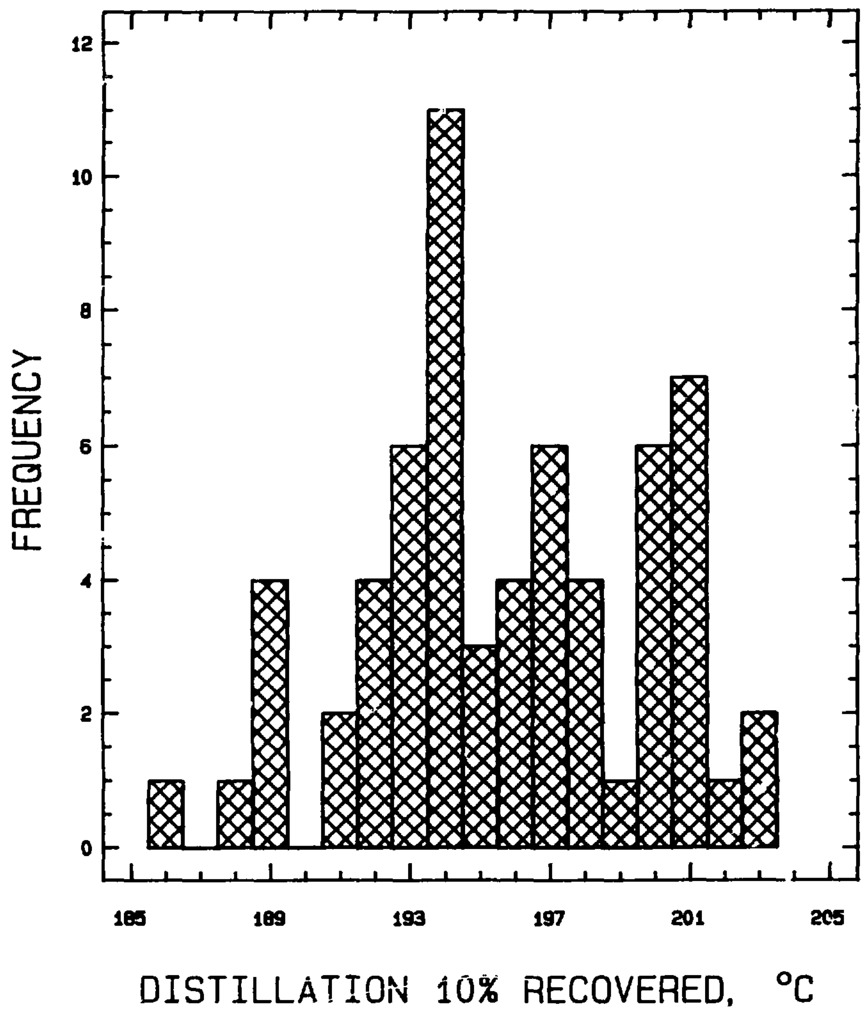

Figure 26. Frequency histogram, JP-5, distillation, 10-percent recovered

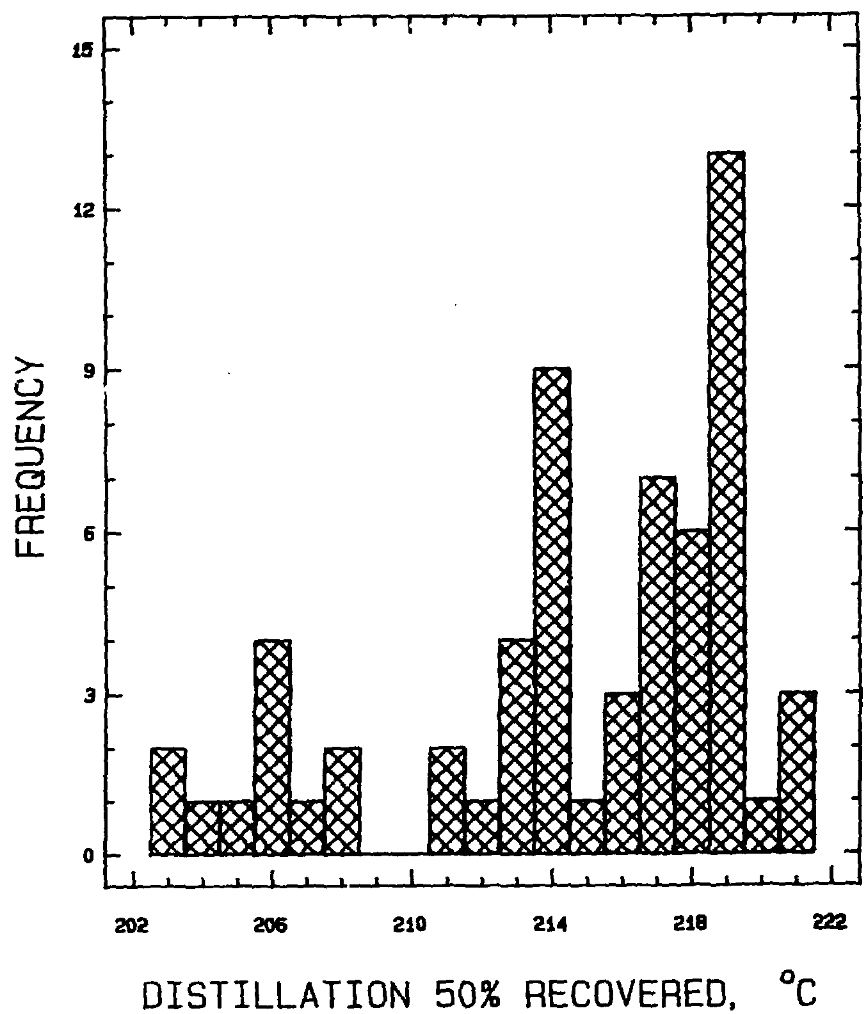

Figure 27. Frequency histogram, JP-5, distillation, 50-percent recovered

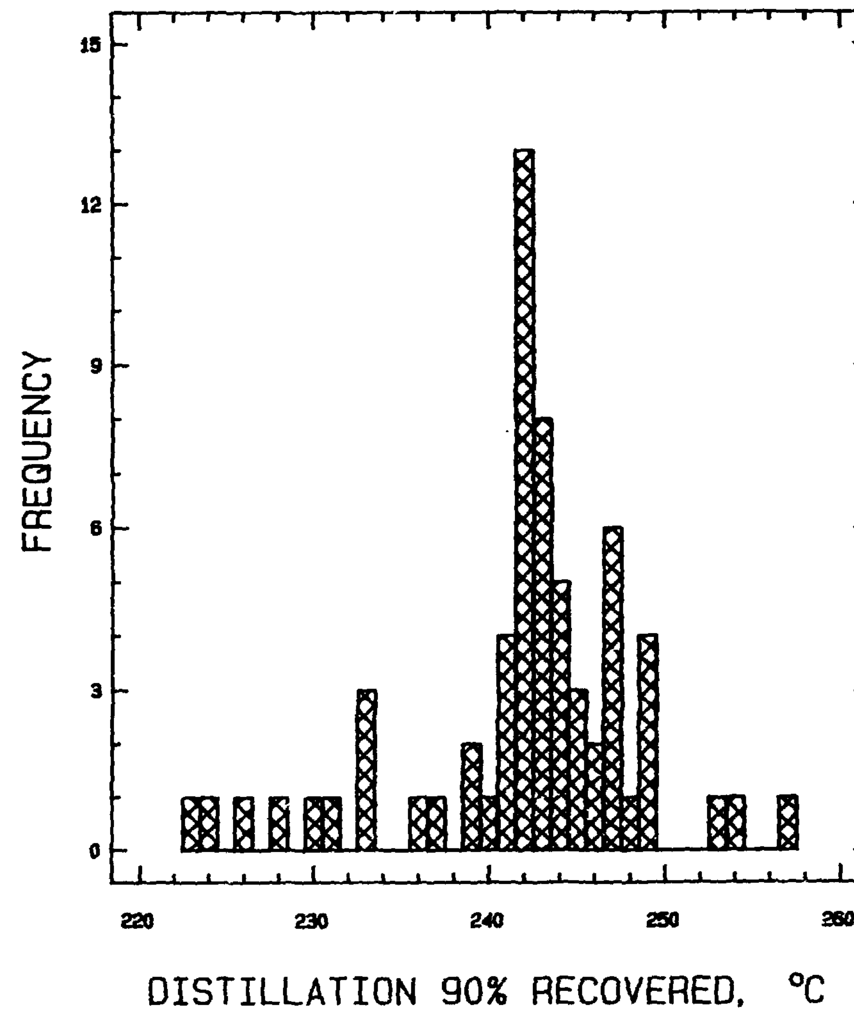

Figure 28. Frequency histogram, JP-5, distillation, 90-percent recovered

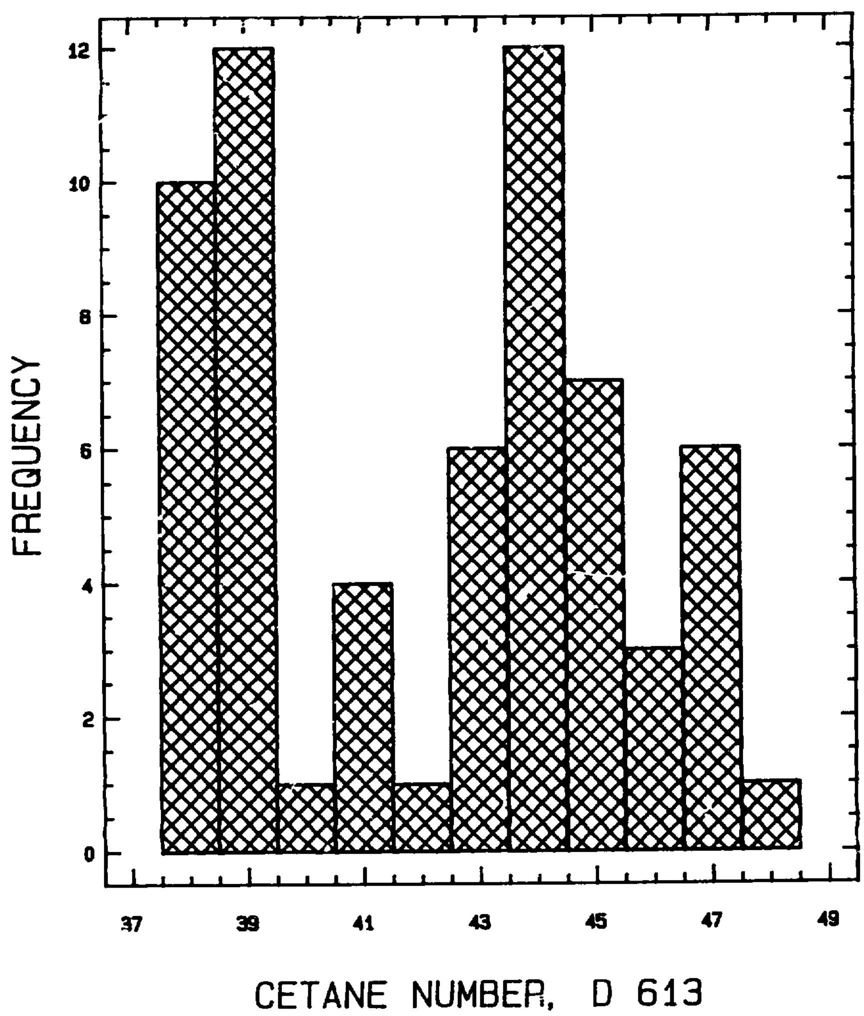

Figure 29. Frequency histogram, JP-5, cetane number, D 613

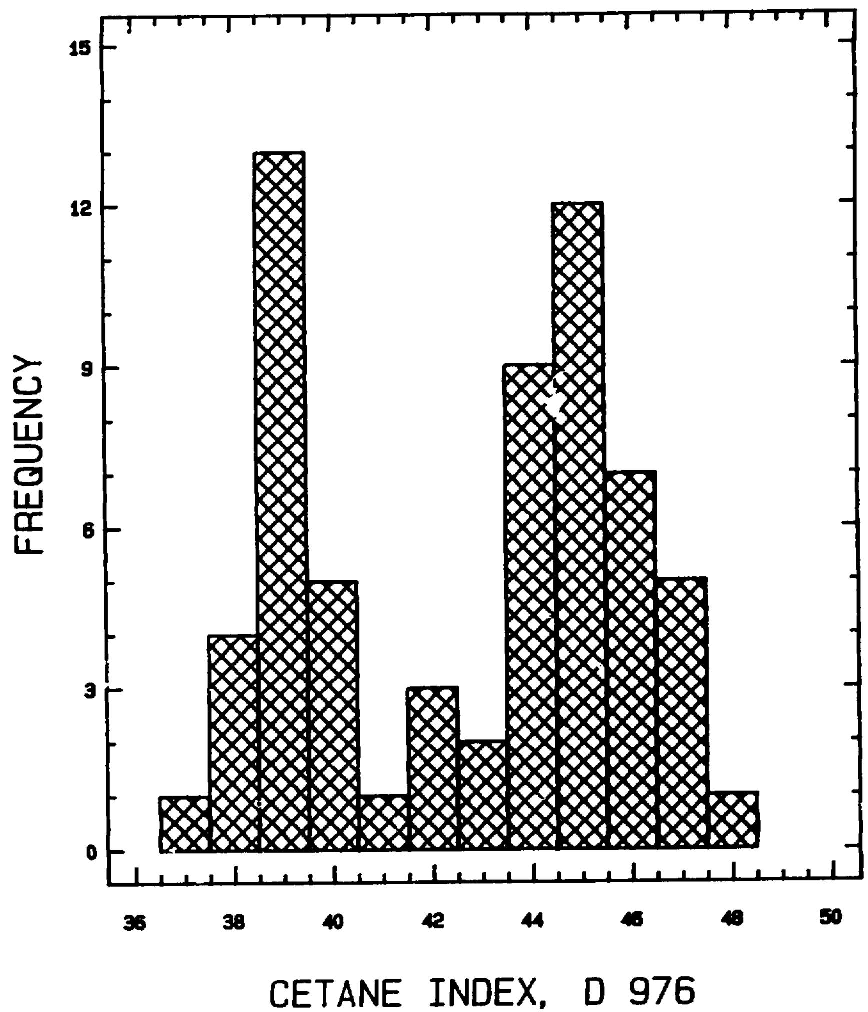

Figure 30. Frequency histogram, JP-5, cetane number, D 976

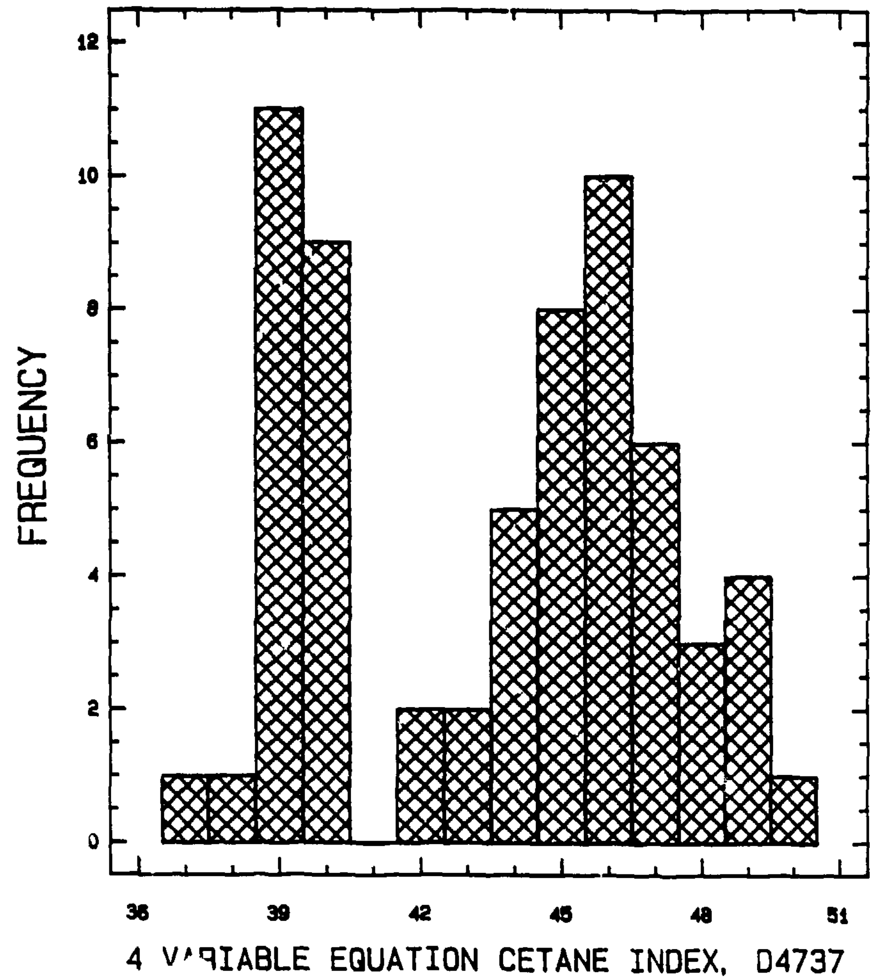

Figure 31. Frequency histogram, JP-5, four variable equation cetane index, D 4737

variable equation cetane index, D 4737, on cetane number, D 613, were performed and are plotted in Figs. 32 and 33, respectively. The linear regression shows a correlation coefficient equal to 0.91 between D 976 and D 613 and 0.87 between D 4737 and D 613. The plots also show t[illegible] lines [illegible] predictability at 95 percent confidence level and the ideal correlation lines.

The correlation coefficients for both calculated cetane index methods and measured cetane number are somewhat [illegible] for the JP-5 than for the JP-8 samples. This improvement can be attributed to the fact that JP-5, because of the higher minimum flash point specified, has a boiling range between 180°C initial boiling point (IBP) and

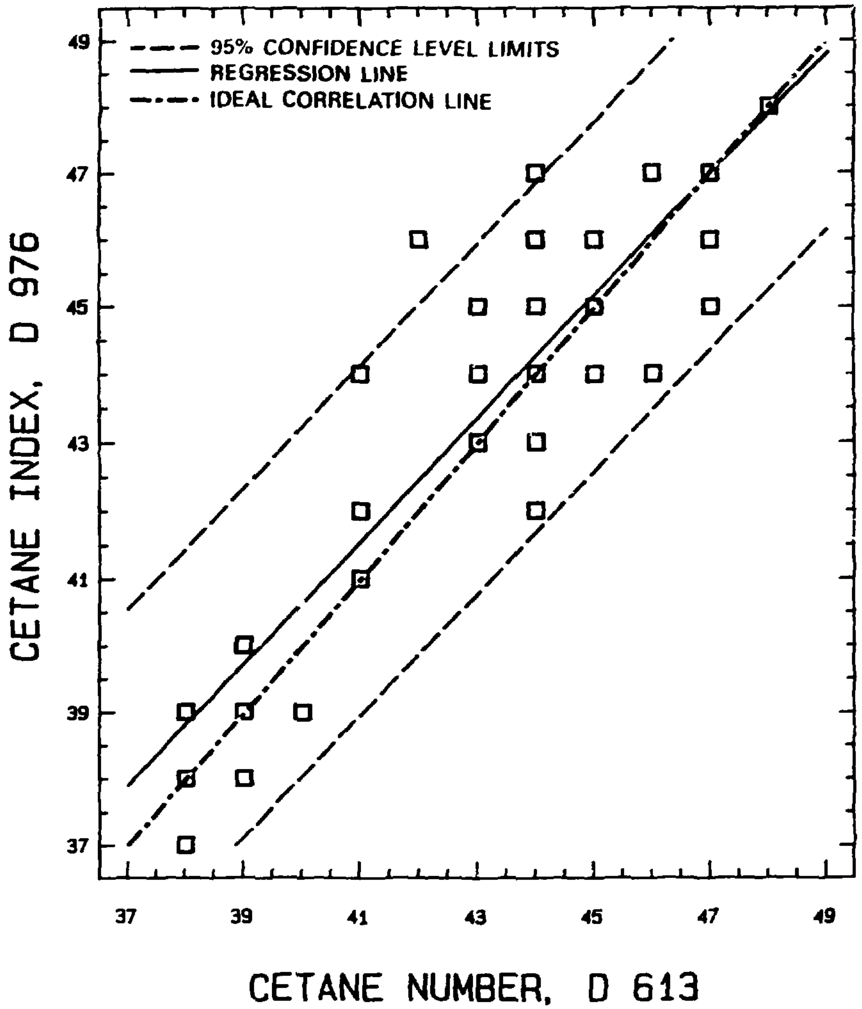

Figure 32. JP-5 regression of cetane index, D 976, on cetane number, D 613

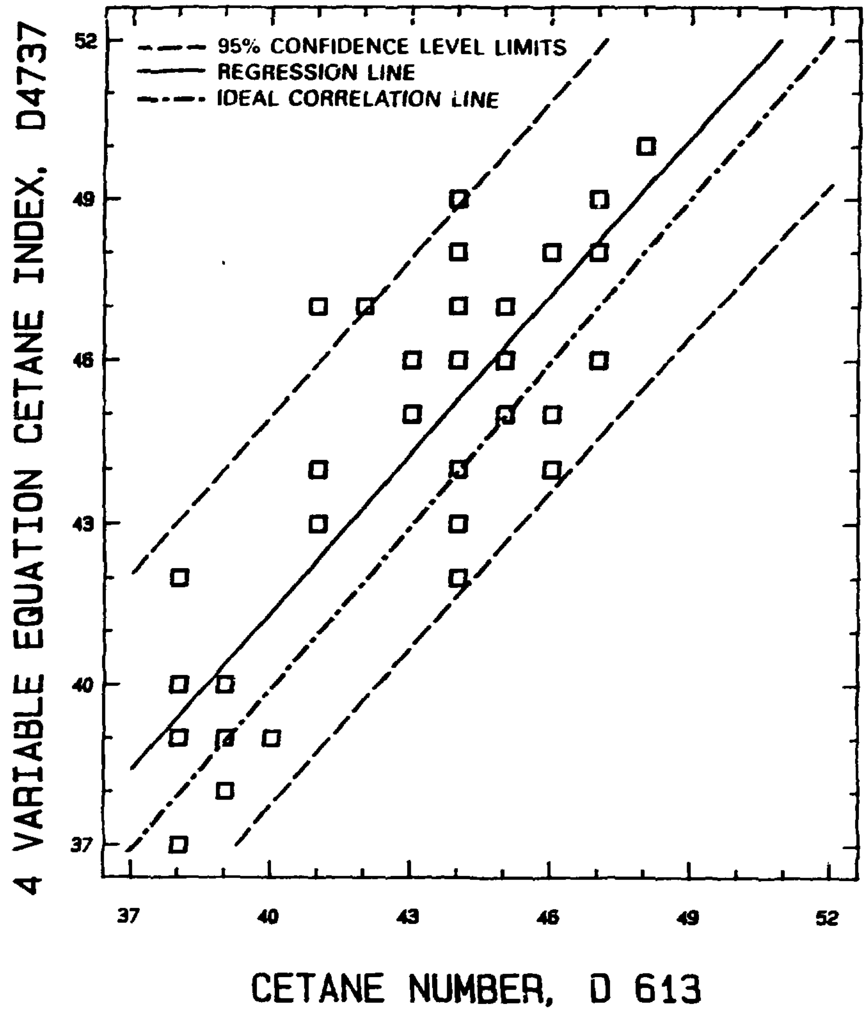

Figure 33. JP-5 regression of four variable equation cetane index, D 4737, on cetane number, D 613

261°C end point (EP), compared to 156°C IBP and 261°C EP for the JP-8 samples. This wider range permits hydrocarbons of lower molecular weight and higher volatility to be part of the JP-8 composition, making this product differ somewhat more than JP-5 from the diesel fuels on which the calculated cetane index procedures are based.

Figs. 32 and 33 show what appear to be 29 and 30 data points, respectively; however, many may represent multiple correlation data points, if more than one sample had identical cetane number and cetane index values as in the case of Fig. 32, or identical cetane number and four-variable equation cetane index values, as in Fig. 33.

5. Kinematic Viscosity

With respect to diesel fuel requirements, one sample was below the limit for kinematic viscosity at 40°C of 1.3 cSt (applicable to both DF-1 and NATO F-54) with a value of 1.29 cSt. Fig. 34 is a frequency histogram for the viscosity at 40°C values. The distribution of the viscosities at 70°C is shown in Fig. 35. TABLE 16 gives the viscosities at four different temperatures for all the 234 JP-5 samples received. As with the JP-8 fuels, the extrapolated values at 100°C and -20°C were obtained using the mathematical relationships shown in Appendix X1 of ASTM Method D 341, "Viscosity Temperature Charts for Liquid Petroleum Products."

6. Sulfur Content

The data for sulfur content show that all the samples analyzed had values below the maximum limit; however, the frequency histogram in Fig. 36 shows a group of samples with below 0.1-percent sulfur, another group with values between 0.23- and 0.27-percent sulfur, and a few between 0.11- and 0.15-percent sulfur. Most of the samples with the higher sulfur content were from California refineries, although a few originated in Texas.

7. Net Heat of Combustion

The net heat of combustion was determined for the 63 samples of JP-5 and reported in MJ/kg, Btu/lb, and Btu/gal. The distribution of the values for Btu/lb is shown in the frequency histogram in Fig. 37 and that for Btu/gal in Fig. 38.

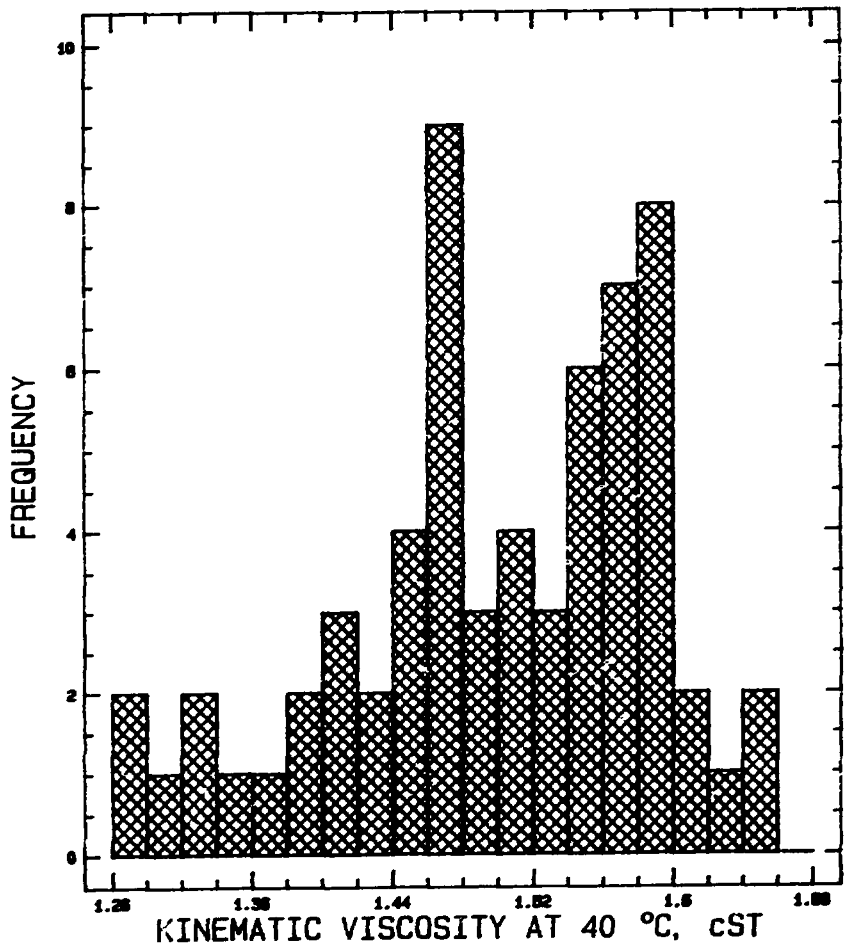

Figure 34. Frequency histogram, JP-5, kinematic viscosity at 40°C

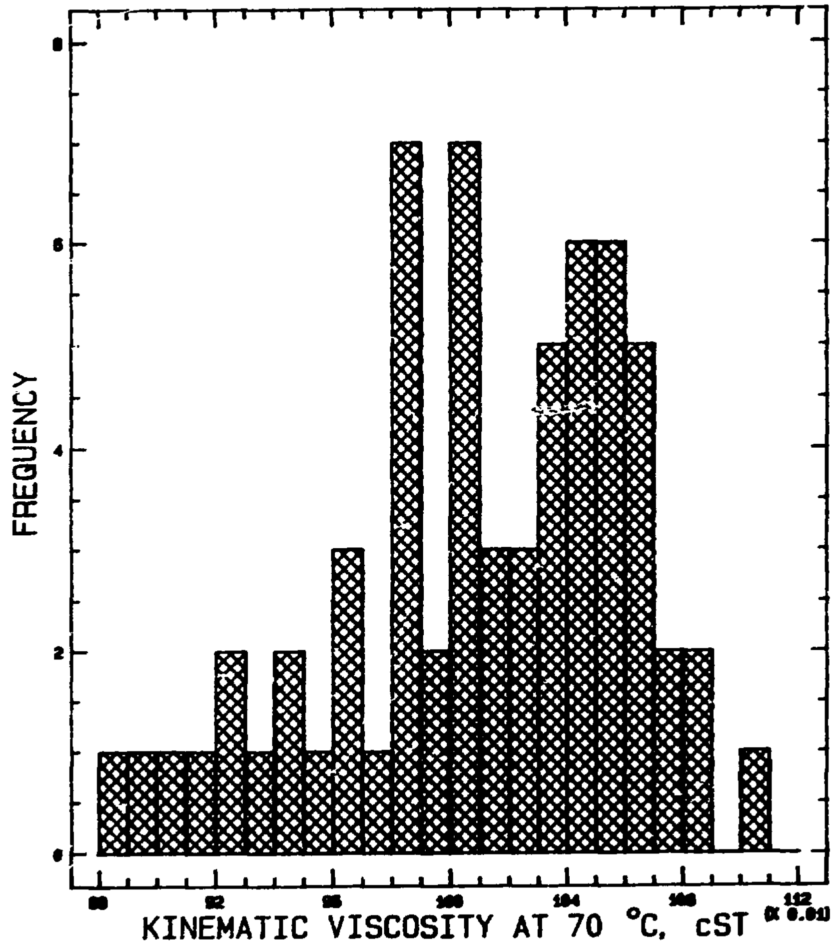

Figure 35. Frequency histogram, JP-5, kinematic viscosity at 70°C

TABLE 10. Kinematic Viscosities of JP-5 Samples

No.	AL-Code No.	Measured K Vis at 40°C (104°F)	Measured K Vis at 70°C (158°F)	Extrapolated K Vis at 100°C (212°F)	Extrapolated K Vis at -20°C (-4°F)	Reported K Vis at -20°C (-4°F)
1	16775	1.53	1.03	0.75	5.8	6.0
2	16792	1.47	0.99	0.72	5.5	5.5*
3	16794	1.39	0.95	0.70	4.9	4.8
4	16795	1.39	0.95	0.70	4.9	5.2
5	16796	1.48	1.01	0.74	5.2	5.2*
6	16824	1.52	1.02	0.74	5.8	5.8*
7	16825	1.46	0.99	0.73	5.3	5.3
8	16826	1.41	0.96	0.70	5.0	5.1
9	16828	1.37	0.94	0.69	4.7	4.7*
10	16829	1.42	0.97	0.71	5.0	5.0*
11	16830	1.52	1.02	0.74	5.8	5.9
12	16831	1.58	1.05	0.76	6.3	6.3
13	16833	1.47	0.99	0.72	5.5	6.0
14	16834	1.60	1.07	0.77	6.2	6.6
15	16835	1.60	1.06	0.76	6.5	6.4
16	16836	1.47	0.99	0.72	5.5	6.0
17	16841	1.46	0.99	0.73	5.3	5.3*
18	16842	1.65	1.09	0.79	6.8	6.6
19	16845	1.55	1.04	0.76	5.9	6.0
20	16846	1.48	1.01	0.74	5.2	5.8
21	16854	1.33	0.93	0.70	4.2	4.9
22	16856	1.66	1.11	0.81	6.5	6.8
23	16857	1.57	1.05	0.76	6.1	6.3
24	16858	1.64	1.09	0.79	6.6	6.3
25	16859	1.60	1.07	0.78	6.2	6.3
26	16861	1.45	0.99	0.73	5.1	6.0
27	16862	1.60	1.08	0.79	5.9	6.5
28	16863	1.29	0.90	0.67	4.1	4.6
29	16864	1.47	1.01	0.75	5.0	3.7
30	16865	1.58	1.06	0.77	6.1	6.4
31	16866	1.32	0.91	0.67	4.4	5.1
32	16917	1.56	1.05	0.77	5.9	6.0
33	16918	1.47	1.00	0.73	5.3	5.3*
34	16919	1.61	1.07	0.77	6.5	6.3
35	16958	1.46	0.99	0.73	5.3	5.3*
36	16961	1.59	1.05	0.76	6.8	6.3
37	16962	1.56	1.04	0.75	6.2	6.1
38	16963	1.55	1.04	0.76	5.9	6.2
39	16964	1.44	0.97	0.71	5.4	5.4*
40	16969	1.57	1.05	0.76	6.1	6.2
41	16970	1.56	1.04	0.75	6.2	6.3
42	17043	1.42	0.97	0.71	5.0	4.8
43	17044	1.54	1.03	0.75	6.0	6.0
44	17047	1.30	0.89	0.66	4.5	4.5
45	17055	1.58	1.06	0.77	6.0	6.2
46	17057	1.61	1.06	0.76	6.8	6.2
47	17058	1.58	1.08	0.80	5.5	6.1
48	17059	1.47	1.00	0.76	4.8	4.8*
49	17060	1.49	1.01	0.74	5.4	4.6
50	17061	1.50	1.01	0.74	5.6	4.6
51	17062	1.60	1.07	0.78	6.2	6.3
52	17063	1.59	1.06	0.77	6.3	6.2
53	17068	1.60	1.07	0.78	6.2	6.5
54	17069	1.49	1.01	0.74	5.4	5.7
55	17070	1.51	1.02	0.74	5.6	5.8
56	17071	1.54	1.04	0.80	5.0	6.0
57	17072	1.44	0.98	0.72	5.1	5.4
58	17073	1.52	1.03	0.75	5.5	6.0
59	17082	1.48	1.01	0.74	5.2	5.2*
60	17083	1.56	1.05	0.77	5.9	6.0
61	17084	1.58	1.06	0.77	6.0	6.2
62	17088	1.34	0.92	0.68	4.6	4.9

* Extrapolated values. Refiner did not report kinematic viscosity at -20°C.

TABLE 10. Kinematic Viscosities of JP-5 Samples (Continued)

No.	AL-Code No.	Measured K Vis at 40°C (104°F)	Measured K Vis at 70°C (158°F)	Extrapolated K Vis at 100°C (212°F)	Extrapolated K Vis at -20°C (-4°F)	Reported K Vis at -20°C (-4°F)
63	17093	1.45	0.99	0.73	5.1	4.4
64	17095	1.47	1.00	0.73	5.3	4.5
65	17098	1.49	1.01	0.74	5.4	5.4*
66	17099	1.55	1.05	0.77	5.7	6.0
67	17100	1.51	1.02	0.75	5.6	5.7
68	17101	1.53	1.03	0.75	5.8	6.0
69	17108	1.54	1.04	0.76	5.7	6.0
70	17109	1.42	0.98	0.73	4.7	5.1
71	17110	1.44	0.99	0.73	4.9	4.9*
72	17111	1.48	1.01	0.74	5.2	4.7
73	17116	1.37	0.95	0.71	4.5	4.9
74	17117	1.56	1.06	0.78	5.6	6.0
75	17121	1.46	1.01	0.75	4.8	5.2
76	17124	1.48	1.01	0.74	5.2	5.2*
77	17125	1.56	1.06	0.78	5.6	6.2
78	17135	1.54	1.04	0.76	5.7	6.2
79	17136	1.47	1.00	0.73	5.3	5.3*
80	17187	1.32	0.92	0.69	4.2	4.2*
81	17188	1.47	1.00	0.73	5.3	5.3*
82	17208	1.56	1.06	0.78	5.6	6.1
83	17209	1.51	1.03	0.76	5.3	5.7
84	17213	1.37	0.95	0.71	4.5	4.9
85	17216	1.54	1.04	0.76	5.7	6.0
86	17217	1.55	1.04	0.76	5.9	6.5
87	17222	1.46	1.00	0.74	5.1	5.1*
88	17223	1.54	1.04	0.76	5.7	6.0
89	17225	1.54	1.00	0.71	7.0	7.0*
90	17226	1.32	0.92	0.69	4.2	4.9
91	17234	1.49	1.04	0.78	4.7	4.7*
92	17235	1.35	0.93	0.69	4.5	4.6
93	17257	1.31	0.91	0.68	4.2	5.1
94	17270	**	**	**	**	**
95	17271	1.39	0.91	0.68	4.2	4.2*
96	17272	1.47	1.00	0.73	5.3	5.0
97	17275	1.47	1.01	0.75	5.0	5.0*
98	17304	1.35	0.93	0.69	4.5	4.9
99	17305	1.46	1.00	0.74	5.1	5.1*
100	17336	1.48	1.01	0.74	5.2	5.2*
101	17337	1.49	1.01	0.74	5.4	5.4*
102	17338	1.48	1.01	0.74	5.2	5.2*
103	17339	1.45	0.99	0.73	5.1	5.1*
104	17340	1.47	1.01	0.75	5.0	5.0*
105	17341	1.46	1.00	0.74	5.1	4.4
106	17350	1.46	1.00	0.74	5.1	5.1*
107	17351	1.40	0.95	0.70	5.1	4.8
108	17352	1.49	1.01	0.74	5.4	5.4*
109	17356	1.59	1.07	0.78	6.0	6.4
110	17357	1.62	1.09	0.80	6.1	6.4
111	17358	1.60	1.07	0.78	6.2	6.3
112	17359	1.59	1.07	0.78	6.0	6.2
113	17362	1.44	0.98	0.72	5.1	4.6
114	17365	1.45	1.00	0.74	4.9	4.9*
115	17373	1.51	1.02	0.75	5.6	5.6*
116	17374	1.56	1.06	0.78	5.6	6.2
117	17375	1.57	1.06	0.78	5.8	6.2
118	17395	1.46	1.00	0.74	5.1	5.4
119	17410	1.53	1.04	0.76	5.5	5.8
120	17411	1.55	1.04	0.76	5.9	6.0
121	17414	1.45	0.97	0.70	5.6	4.8
122	17415	1.40	0.99	0.75	4.2	4.2*

* Extrapolated values. Refiner did not report kinematic viscosity at -20°C.
** This sample was not found.

TABLE 10. Kinematic Viscosities of JP-5 Samples (Continued)

No.	AL-Code No.	Measured K Vis at 40°C (104°F)	Measured K Vis at 70°C (158°F)	Extrapolated K Vis at 100°C (212°F)	Extrapolated K Vis at -20°C (-4°F)	Reported K Vis at -20°C (-4°F)
123	17416	1.52	1.03	0.75	5.5	5.5*
124	17422	1.28	0.89	0.66	4.1	4.9
125	17424	1.58	1.06	0.77	6.1	6.3
126	17496	1.58	1.06	0.77	6.1	6.2
127	17501	1.54	1.04	0.76	5.7	6.3
128	17504	1.40	0.96	0.71	4.8	4.8*
129	17519	1.59	1.07	0.78	6.0	6.1
130	17521	1.30	0.90	0.67	4.3	4.5
131	17522	1.59	1.07	0.78	6.0	6.4
132	17523	1.55	1.05	0.77	5.7	6.1
133	17524	1.54	1.03	0.75	6.0	6.0*
134	17525	1.50	1.02	0.75	5.4	5.4*
135	17526	1.39	0.95	0.70	4.9	4.7
136	17527	1.33	0.93	0.70	4.2	4.2*
137	17531	1.54	1.04	0.76	5.5	6.1
138	17532	1.45	0.99	0.73	5.1	5.1*
139	17535	1.37	0.94	0.69	4.7	4.8
140	17539	1.42	0.97	0.71	5.0	4.3
141	17543	1.53	1.04	0.76	5.5	5.5*
142	17552	1.56	1.05	0.77	5.9	6.1
143	17561	1.57	1.05	0.76	6.1	6.3
144	17562	1.36	0.94	0.70	4.5	4.9
145	17563	**	**	**	**	**
146	17564	1.40	0.96	0.71	4.8	4.1
147	17565	1.46	0.99	0.73	5.3	5.3*
148	17567	1.43	0.98	0.72	4.9	4.8
149	17587	1.51	1.03	0.76	5.3	5.3*
150	17588	1.58	1.06	0.77	6.1	6.3
151	17595	1.45	0.99	0.73	5.1	5.2
152	17600	1.46	0.99	0.73	5.3	5.3*
153	17602	1.54	1.04	0.76	5.7	5.7*
154	17603	1.62	1.08	0.78	6.4	6.5
155	17605	1.55	1.04	0.76	5.9	6.2
156	17620	1.35	0.93	0.69	4.5	4.6
157	17622	1.41	0.97	0.72	4.8	4.1
158	17626	1.57	1.05	0.76	6.1	6.1
159	17628	1.37	0.96	0.72	4.3	5.3
160	17640	1.57	1.06	0.78	5.8	6.1
161	17641	1.42	0.97	0.71	5.0	5.4
162	17642	1.53	1.03	0.75	5.8	5.4
163	17643	1.58	1.06	0.77	6.1	6.0
164	17644	1.60	1.07	0.78	6.2	6.5
165	17645	1.61	1.08	0.79	6.2	6.5
166	17646	1.60	1.07	0.78	6.2	6.6
167	17647	1.59	1.07	0.78	6.0	6.0
168	17695	1.61	1.07	0.77	6.5	6.4
169	17700	1.46	1.00	0.74	5.1	5.1*
170	17701	1.49	1.02	0.75	5.2	5.2*
171	17706	1.40	0.97	0.72	4.6	4.1
172	17722	1.38	0.95	0.70	4.7	3.9
173	17726	1.58	1.06	0.77	5.1	6.2
174	17727	1.42	0.98	0.73	4.7	4.8
175	17728	1.38	0.95	0.70	4.7	5.1
176	17730	1.58	1.06	0.77	6.1	6.1
177	17733	1.54	1.04	0.76	5.7	6.1
178	17734	1.33	0.99	0.78	3.2	3.2*
179	17739	1.40	0.97	0.72	4.6	4.8
180	17740	1.70	1.13	0.82	6.8	6.8*
181	17747	1.57	1.05	0.76	6.1	6.1
182	17748	1.39	0.95	0.70	4.9	4.1
183	17749	1.36	0.94	0.70	4.5	4.5*
184	17756	1.40	0.96	0.71	4.8	4.5

* Extrapolated values. Refiner did not report kinematic viscosity at -20°C.
** This sample was not found.

TABLE 10. Kinematic Viscosities of JP-5 Samples (Continued)

No.	AL-Code No.	Measured K Vis at 40°C (104°F)	Measured K Vis at 70°C (158°F)	Extrapolated K Vis at 100°C (212°F)	Extrapolated K Vis at -20°C (-4°F)	Reported K Vis at -20°C (-4°F)
185	17764	1.47	1.00	0.73	5.3	5.3*
186	17765	1.52	1.03	0.75	5.5	5.6
187	17766	1.53	1.03	0.75	5.8	5.8*
188	17784	1.43	0.98	0.72	4.9	4.4
189	17785	1.45	0.99	0.73	5.1	5.1*
190	17786	1.57	1.06	0.78	5.8	6.1
191	17787	1.62	1.08	0.78	6.4	6.4
192	17794	1.53	1.03	0.75	5.8	5.9
193	17795	1.53	1.03	0.75	5.8	5.7
194	17796	1.37	0.94	0.69	4.7	4.6
195	17805	1.61	1.07	0.77	6.5	6.5*
196	17806	1.55	1.04	0.76	5.9	5.9*
197	17810	1.40	0.96	0.71	4.8	4.2
198	17811	1.52	1.02	0.74	5.8	5.6
199	17814	1.47	1.00	0.73	5.3	5.3*
200	17815	1.51	1.03	0.76	5.3	5.3*
201	17827	1.45	0.98	0.72	5.3	4.0
202	17831	1.53	1.03	0.75	5.8	5.8
203	17832	1.53	1.03	0.75	5.8	5.7
204	17833	1.52	1.02	0.74	5.8	5.5
205	17836	1.54	1.04	0.76	5.7	5.8
206	17837	1.51	1.02	0.75	5.6	4.2
207	17853	1.60	1.07	0.78	6.2	6.3
208	17854	1.60	1.07	0.78	6.2	5.0
209	17855	1.56	1.05	0.77	5.9	6.4
210	17904	1.45	0.99	0.73	5.1	3.9
211	17905	1.61	1.07	0.77	6.5	6.3
212	17906	1.49	1.01	0.74	5.4	5.4*
213	18106	1.52	1.03	0.75	5.5	5.9
214	18117	1.57	1.05	0.76	6.1	6.1
215	18118	1.67	1.11	0.80	6.7	6.7*
216	18119	1.68	1.12	0.81	6.6	7.1
217	18122	1.54	1.04	0.76	5.7	6.0
218	18124	1.45	1.00	0.74	4.9	4.9*
219	18125	1.49	1.02	0.75	5.2	5.2*
220	18126	1.59	1.07	0.78	6.0	6.1
221	18140	1.46	0.99	0.73	5.3	5.3*
222	18142	1.34	0.93	0.69	4.3	4.6
223	18153	1.61	1.08	0.79	6.2	6.5
224	18154	1.61	1.08	0.79	6.2	6.5
225	18155	1.44	0.99	0.73	4.9	4.9*
226	18156	1.44	0.98	0.72	5.1	3.9
227	18158	1.50	1.02	0.75	5.4	6.0
228	18159	1.49	1.01	0.74	5.4	6.0
229	18166	1.45	0.99	0.73	5.1	3.9
230	18167	1.51	1.02	0.75	5.6	5.6*
231	18169	1.60	1.07	0.78	6.2	6.5
232	18170	1.58	1.06	0.77	6.1	5.2
233	18171	1.59	1.07	0.78	6.0	6.3
234	18172	1.59	1.06	0.77	6.3	6.2

* Extrapolated values. Refiner did not report kinematic viscosity at -20°C.

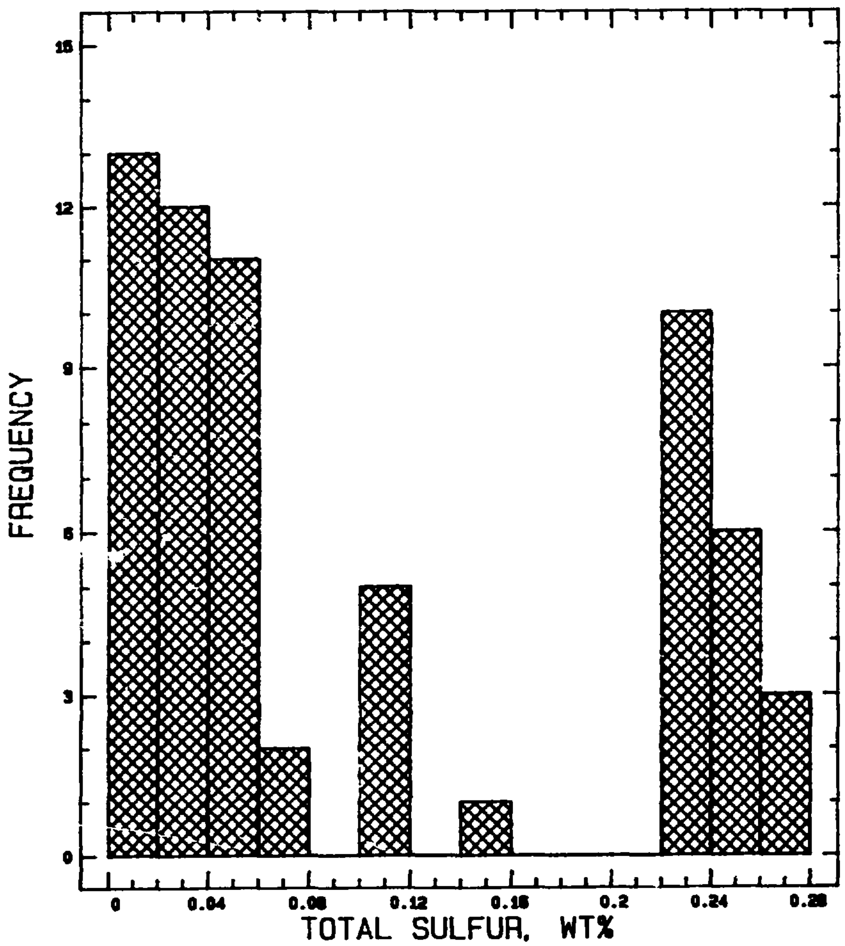

Figure 36. Frequency histogram, JP-5, sulfur content

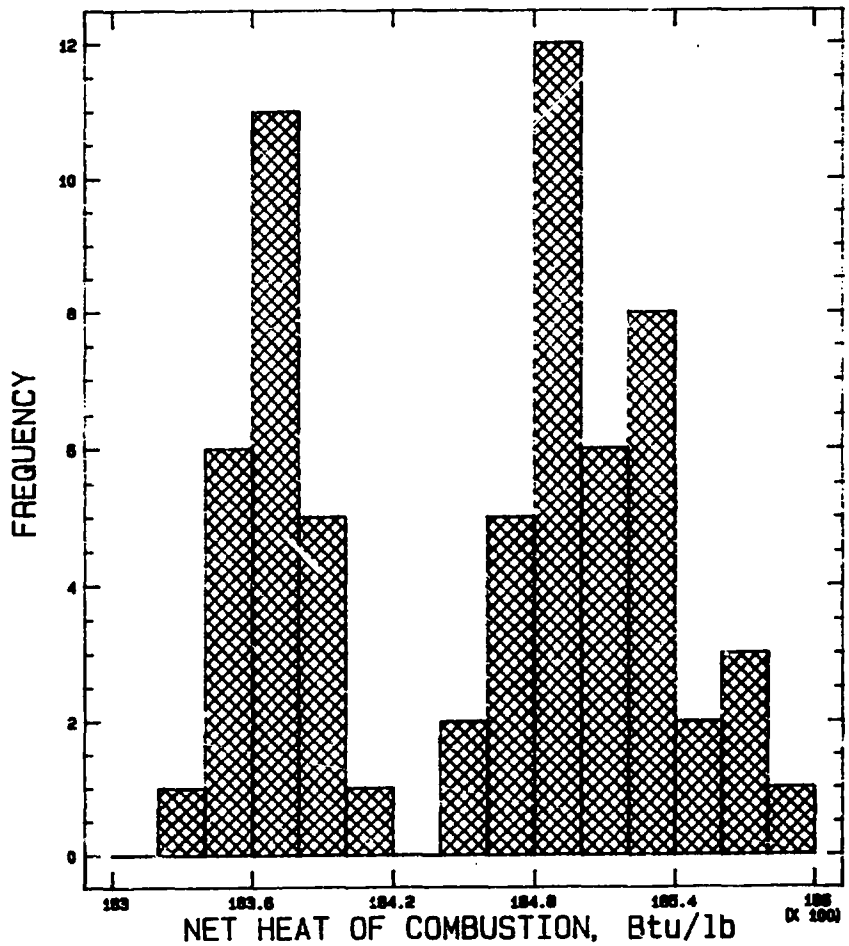

Figure 37. Frequency histogram, JP-5, net heat of combustion, Btu/lb

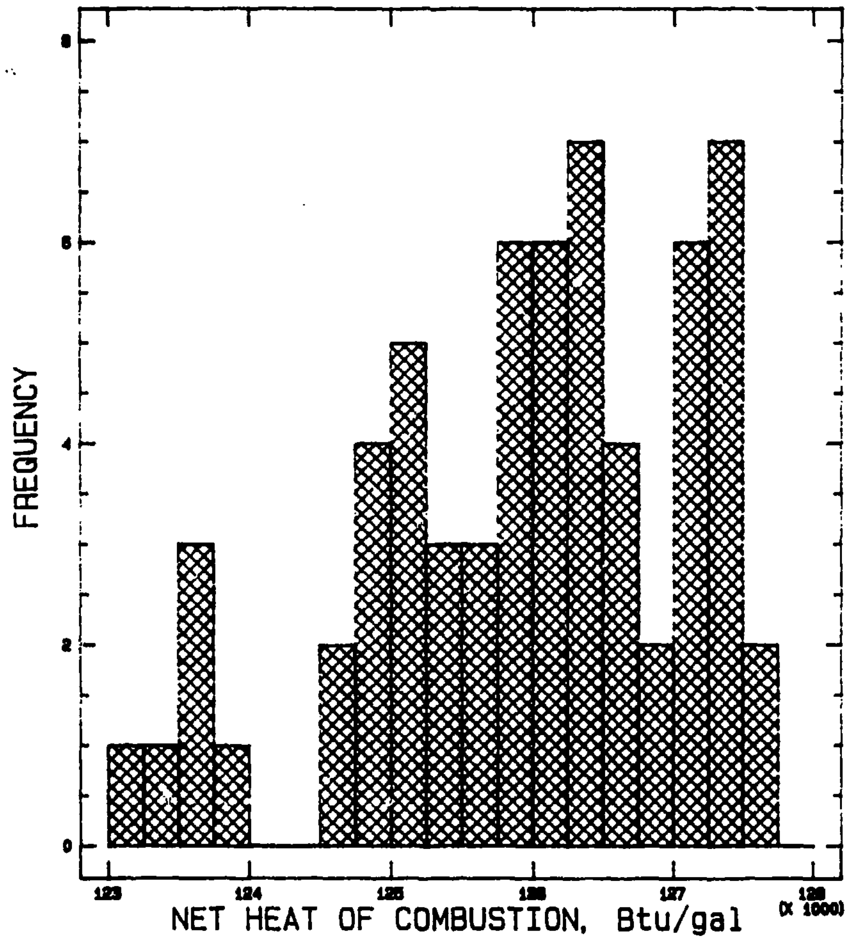

Figure 38. **Frequency histogram, JP-5, net heat of combustion, Btu/gal.**

8. Aromatics and Olefins

Hydrocarbon-type analyses for the JP-5 samples were reported by the refiners, and these data were used to prepare the frequency histograms for aromatic and olefin content shown in Figs. 39 and 40, respectively.

9. Hydrogen Content

The limit for hydrogen content in JP-5 is 13.4 wt% minimum as determined by ASTM D 3701, "Hydrogen Content of Aviation Turbine Fuels by Low Resolution Nuclear Magnetic Resonance;" however, only a very few of the suppliers reported this property

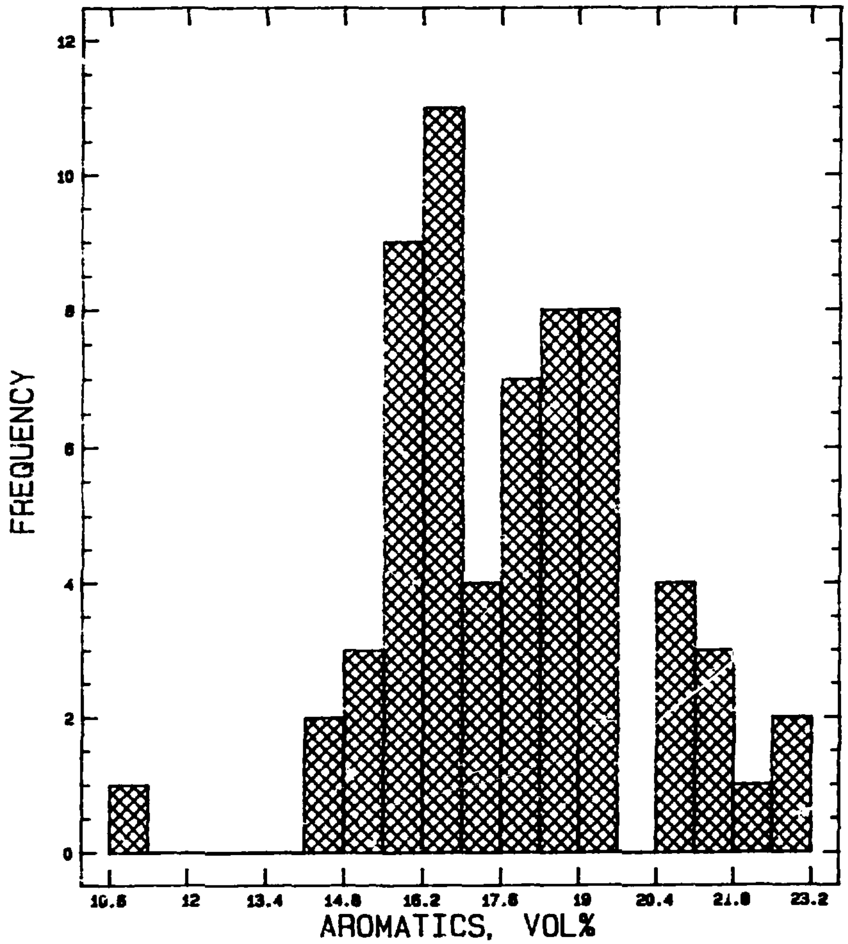

Figure 39. Frequency histogram, JP-5, aromatics

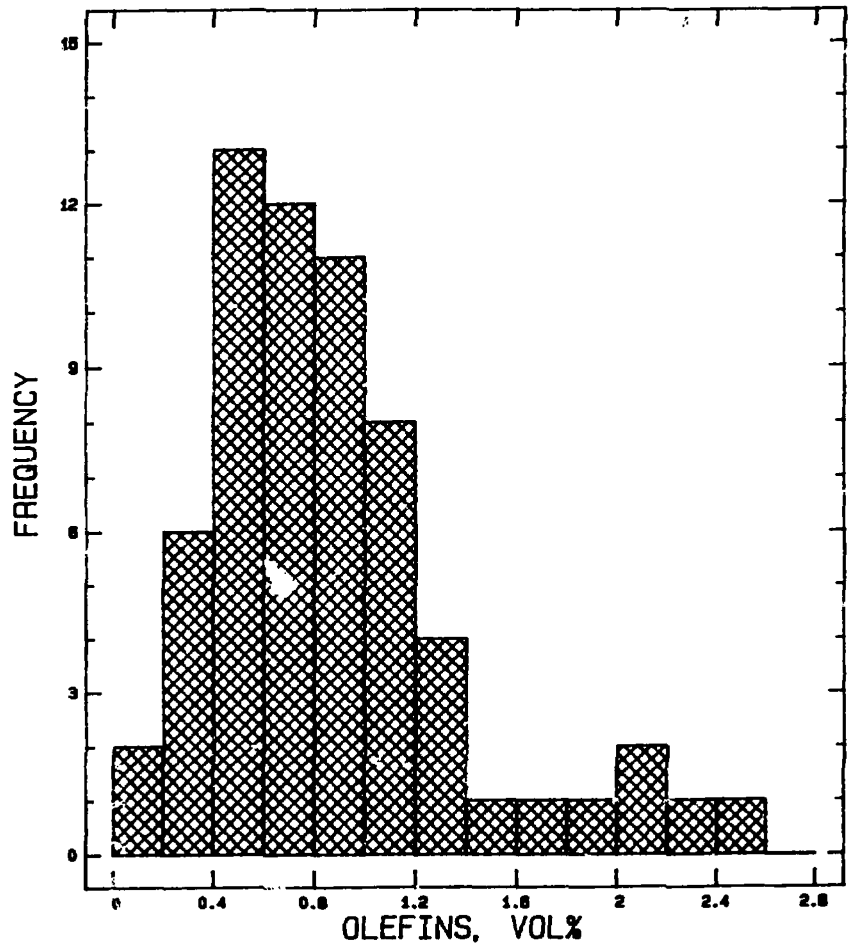

Figure 40. Frequency histogram, JP-5, olefins

for their samples. The values obtained at BFLRF were by a modification of ASTM D 3178, Carbon and Hydrogen in the Analysis Sample of Coal and Coke. Ten of the 63 samples analyzed by this method had hydrogen content below the limit for JP-5. Fig. 41 is a frequency histogram for the JP-5 hydrogen content values.

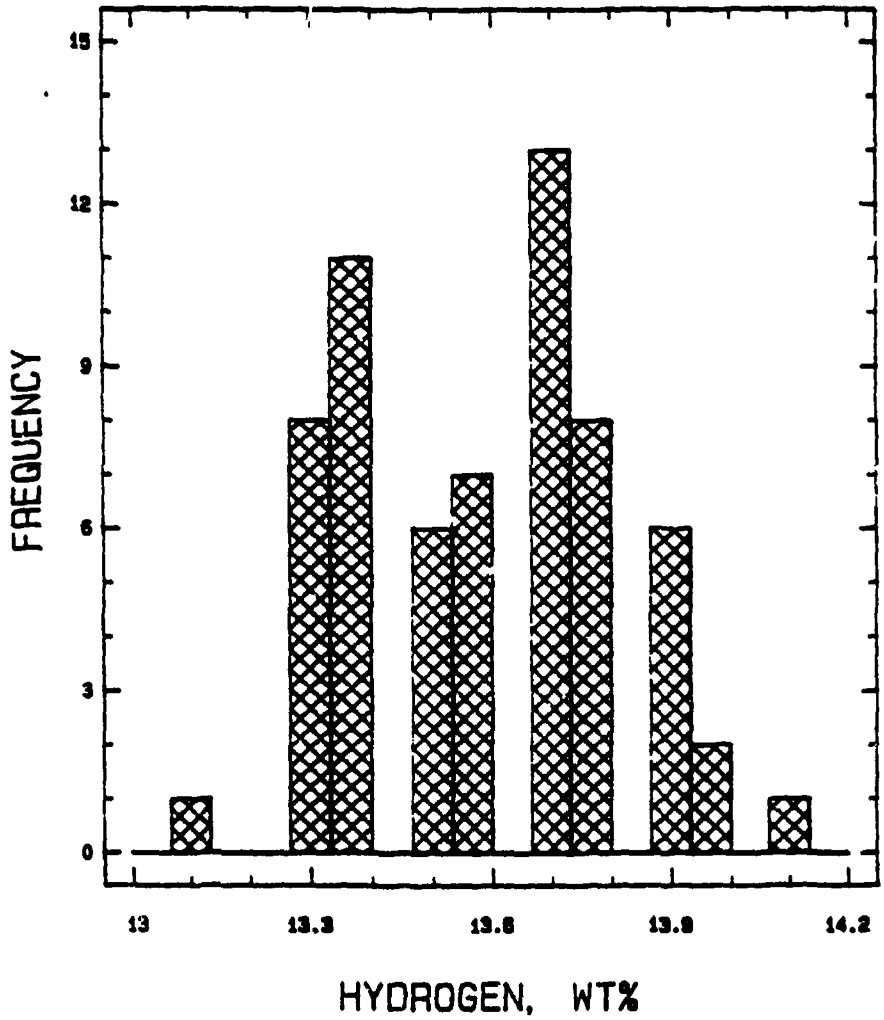

Figure 41. Frequency histogram, JP-5, hydrogen content

C. Comparison of JP-8/JP-5 Properties With Diesel Fuel Properties

The concept of having one fuel for use in combat aircraft as well as combat ground vehicles and equipment is very attractive from a logistics viewpoint. The use of JP-8 aircraft fuel with a -47°C freezing point in ground vehicles during the winter will avoid the problems of wax crystallization that occurs in diesel fuels with cloud points of -13°C and pour points of -18°C. Nevertheless, there are concerns associated with use of the

lighter JP-8 and JP-5 in diesel engines. To address these concerns, certain JP-8 and JP-5 fuel properties important for satisfactory operation of diesel engines were examined more closely and compared to the average characteristics of diesel fuel.

The determined cetane numbers (i.e., D 613) for the JP-8 samples all met the requirements of DF-A, DF-1, and DF-2, with one exception. One sample had a cetane number of 38. The average cetane number value for the JP-8 samples evaluated was 44.9, indicating that JP-8 fuels should have adequate ignition quality for use in compression ignition engines. Many samples, however, were below the requirements of F-54, which is 45 minimum. The JP-5 samples had an average cetane number of 42.7, also indicative of adequate ignition quality for diesel engine operation. Many of the JP-5 samples, primarily those refined on the west coast where the crudes available are mostly heavy aromatic, had cetane numbers below 40.

The correlations between determined cetane numbers, D 613, and cetane index, D 976, or four variable equation cetane index, D 4737, were better for the JP-5 samples than for the JP-8 samples, based on the correlation coefficients calculated for the two types of fuels. The cetane index method, D 976, appears to be slightly better and is simpler to use. Both military specifications for aircraft turbine fuels, MIL-T-83133B for Grade JP-8 and MIL-T-5624M for JP-5, recommend the use of this method for calculating the cetane index. However, in both methods it is stated that the mid-boiling temperatures may be obtained by either D 86, Distillation of Petroleum Products, or D 2887, Boiling Range Distribution of Petroleum Fractions by Gas Chromatograph. Method D 976 requires the 50 percent temperature determined by D 86 be used in the calculation equation; therefore, the statements in the military specifications should be corrected.

The kinematic viscosity at 40°C is not a requirement for aircraft turbine fuels but is important for diesel fuel application; therefore, this property was determined in all the samples of both JP-8 and JP-5. This kinematic viscosity is of special concern because the manufacturer of one fuel injection pump used in a high density vehicle indicated that increased wear may occur in its pump with the use of low viscosity turbine engine fuels. In addition to values obtained at the standard 40°C temperature, measurements were made at 70°C to enable the estimation of viscosities at any desired temperature.

Fig. 42 shows the viscosity-temperature relationships for both JP-8 and JP-5 survey samples and gives plots for the average, minimum, and maximum values for each type of

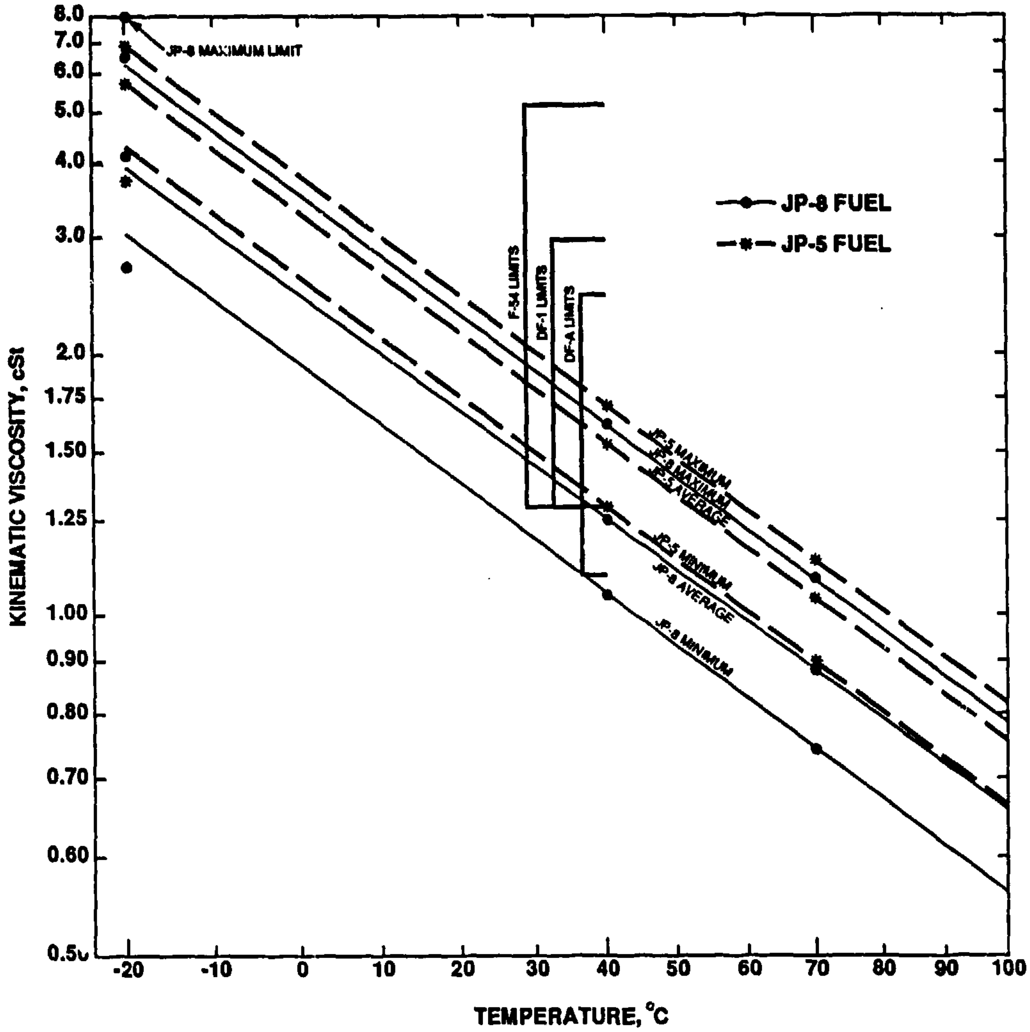

Figure 42. Viscosity temperature relationships of JP-8 and JP-5 survey samples

fuel. The JP-5 fuels show generally higher viscosity values than the JP-8 samples. The figure also shows the specification limits for VV-F-800 grades DF-A, DF-1 and NATO F-54 fuels. The JP-8 fuel with the lowest kinematic viscosity at 40°C, shown in Fig. 42 as "JP-8 minimum," does not meet the lower limit of 1.1 cSt at 40°C for DF-A; however, most of the JP-8 samples were above this limit.

The National Institute for Petroleum and Energy Research (NIPER) Diesel Fuel Oils, 1987 (survey) (9) gives an average value of kinematic viscosity at 100°F for 2-D fuels of 2.87 cSt, which is estimated to be about 2.73 cSt at 40°C (104°F). An "Ethyl European Diesel Fuel Survey, Winter 1987/1988,"(10) gives a mean kinematic viscosity at 20°C of 4.22 cSt for 53 European diesel fuels, which is estimated to be equivalent to 2.80 cSt at 40°C.

The higher volatility of JP-8 when compared to DF-2 has also been a concern of future users of this fuel in diesel engines. To investigate this issue, true vapor pressure (TVP) data calculated using ASTM Method D 2889 were developed for JP-8, 1-D, 2-D, and JP-4 fuels as shown in TABLE 11. The data provide a comparison of API gravity, distillation, true vapor pressure at various temperatures, and other properties developed with Method D 2889. The fuels listed were chosen to represent vapor pressure extremes for each type of fuel. The data show that the true vapor pressures of 1-D and JP-8 fuels are in the same range, while the TVP for 2-D is generally lower. The TVP for JP-4 fuels is of an order of magnitude higher than for the other fuels.

The net or lower volumetric heat of combustion for JP-8 fuels is typically less than that for DF-2 and F-54 fuels, which is also of concern to future users of JP-8 because of anticipated increase in fuel consumption. TABLE 12 was constructed to provide an estimate of the expected differences between the net heat of combustion for F-54, and the heats of combustion for DF-2/2-D, EPA certification fuel, JP-8, JP-5, and F-65 fuels. Two examples of F-65 are shown: one formulated with equal volumes of F-54 and JP-8, and the other formulated with equal volumes of F-54 and JP-5. The data show about 3.6-percent loss in heating value when going from F-54 to JP-8 and 1.8-percent loss when going from F-54 to F-65 blended with JP-8. Losses going from F-54 to JP-5 and F-65 made with JP-5 were less than those observed with JP-8.

TABLE 12. Net Heat of Combustion

Fuel Average	Net Heat of Combustion Btu/lb	Net Heat of Combustion Btu/gal.	% Change in Net Heat of Combustion Compared to F-54
DF-2/2-D Average Fuels*	18,396	130,575	+2.2
EPA Endurance/Certification** Fuel	18,388	129,874	+0.2
2 F-54 Samples	18,413	127,776	0.0
93 JP-8 Samples	18,494	123,138	-3.6
63 JP-5 Samples	18,456	125,964	-1.4
F-65 (F-54 + JP-8)	18,454	125,457	-1.8
F-65 (F-54 + JP-5)	18,435	126,870	-0.7

* Estimated from NIPER 1987 survey data (9), assuming 30 percent average aromatics.

** Estimated from data for a fuel used in certification tests.

TABLE 11. Comparison of Gravity, Distillation, and True Vapor Pressure at Various Temperatures

Sample	Gravity, °API	D 86 Distillation, °F							D 2889, True Vapor Pressure (TVP), at °F, psia					D 2889, Other Properties		
		IBP	10%	30%	50%	70%	90%	FBP	100	200	300	400	500	Equilibrium Flash Vaporization, 0% Temperature, °F	Volumetric Average Boiling Point, °F	Slope, °F/vol%
A) JP-8(a)	45.1	342	371	393	410	430	462	504	--	1.2	6	21	57	377	413	1.1
B) JP-8(a)	49.3	304	332	348	366	392	429	482	--	2	9	31	82	335	373	1.1
A) 1-D Diesel(b)	42.2	393	412	431	450	480	510	542	--	1	1.5	11	35	425	457	1.2
B) 1-D Diesel(b)	39.9	262	379	400	421	447	473	508	--	2.5	10	29	70	331	424	1.2
A) 2-D Diesel(b)	31.7	476	509	528	548	577	607	648	--	1	1	2.8	10	527	554	1.6
B) 2-D Diesel(b)	32.4	315	418	461	503	545	587	631	--	1.1	5	17	44	388	503	3.4
A) JP-4(c)	54.6	152	232	263	295	368	441	501	4.6	18	55	130	250	178	320	3.6
B) JP-4(c)	53.1	79	163	215	268	321	375	479	12	44	110	230	400	111	268	3.7

*A and B samples are maximum and minimum values from each survey.

(a) Current JP-8 worldwide fuels data base, 59 samples.

(b) Summary for 1-D and 2-D Fuels, 1985, NIPER.(11)

(c) Inspection Data for Aviation Turbine Fuels, 1985, NIPER.(12)

V. CONCLUSIONS AND RECOMMENDATIONS

The data reported herein indicate that many of the JP-8 fuels being supplied in Europe meet the DF-1 viscosity requirements and several fall in DF-A viscositv range. Virtually all samples had cetane numbers of 40 and above. The JP-5 fuels being supplied in the U.S. meet the viscosity requirements for DF-1, but many have cetane numbers below the 40 minimum requirement.

The calculation of cetane index values by either ASTM method did not correlate completely satisfactorily when applied to the JP-8 fuels; however, the correlations applied to JP-5 fuels were satisfactory. It is recommended that the shortcomings of these correlations be investigated to determine if they can be improved for application to JP-8 fuels. In the interim, the ASTM D 976 procedure for calculating cetane index should be used with 50 percent distillation temperature determined by ASTM D 86.

All the JP-5 and many of the JP-8 fuels met the viscosity requirements of VV-F-800 grades DF-A and DF-1 diesel fuels; however, a few of the JP-8 samples had values below the DF-A limit of 1.1 cSt, and many were below the DF-1 limit of 1.3 cSt.

Based on estimated volumetric net heat of combustion values for DF-2, F-54 and EPA certification diesel fuels, and measured values for JP-8 and JP-5, it would appear that fuel consumption may increase when using aircraft turbine fuels in some diesel engines. However, some of the other anticipated benefits in using these fuels such as reduced nozzle fouling, reduced cold weather filter plugging, etc. may offset this lowered heat of combustion characteristic.

VI. REFERENCES

1. Bowden, J.N. and Wimer, W.W., "Universal Fuel Requirements," U.S. Army Fuels and Lubricants Research Laboratory, Interim Report AFLRL No. 67 (AD A016157), prepared by U.S. Army Fuels and Lubricants Research Laboratory, Southwest Research Institute, San Antonio, Texas, May 1975.

2. Watson, W.W. and Wise, J.J., "Substitution of JP-5 for Diesel Fuel Ashore," Technical Note N-660, U.S. Naval Civil Engineering Laboratory, Port Hueneme, California, 15 February 1965.

3. Wise, J.J., Phelps, S., "Heavy Equipment Operators," Evaluation JP-5 Versus DF-2," Technical Note N-693, U.S. Naval Civil Engineering Laboratory, Port Hueneme, California, 13 May 1965.

4. Watson, W.W., "The Use of JP-5 Aviation Turbine Fuel in Large-Bore, Low-Speed Diesel Engines," Technical Note N-743, U.S. Naval Civil Engineering Laboratory, Port Hueneme, California, 15 November 1965.

5. Bowden, J.N., Owens, E.C. and LePera, M.E., "JP-8 and JP-5 as Compression Ignition Engine Fuel," Interim Report AFLRL No. 192 (AD A150796), prepared by U.S. Army Fuels and Lubricants Research Laboratory, Southwest Research Institute, San Antonio, Texas, January 1985.

6. Department of Defense Directive 4140.43, Subject: "Fuel Standardization," 11 March 1988.

7. Army Regulation AR-703-1, "Coal and Petroleum Products Supply and Management Activities," 27 August 1985.

8. Bowden, J.N., Stavinoha, L.L., "Emergency Fuels Technology," Interim Report AFLRL No. 155 (AD A125275), prepared by U.S. Army Fuels and Lubricants Research Laboratory, Southwest Research Institute, San Antonio, Texas, June 1982.

9. Dickson, C.L. and Woodward, P.W., "Diesel Fuel Oils, 1987," National Institute for Petroleum and Energy Research," NIPER-152 PPS, October 1987.

10. Ethyl European Diesel Fuel Survey, Winter 1987/88.

11. Shelton, E.M. and Dickson, C.L., "Diesel Fuel Oils, 1985," National Institute for Petroleum and Energy Research, NIPER-142 PPS, October 1985.

12. Dickson, C.L. and Woodward, P.W., "Aviation Turbine Fuels, 1985," National Institute for Petroleum and Energy Research, NIPER-144 PPS, May 1986.

APPENDIX A

Frequency Tabulation for Individual Property

TABLE A-1. Frequency Tabulation for JP-8 API Gravity (Refer to Fig. 1)

Frequency Tabulation

Class	Lower Limit	Upper Limit	Midpoint	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
at or below		40.00		0	.0000	0	.0000
1	40.00	40.50	40.25	0	.0000	0	.0000
2	40.50	41.00	40.75	3	.0323	3	.0323
3	41.00	41.50	41.25	4	.0430	7	.0753
4	41.50	42.00	41.75	2	.0215	9	.0968
5	42.00	42.50	42.25	1	.0108	10	.1075
6	42.50	43.00	42.75	3	.0323	13	.1398
7	43.00	43.50	43.25	1	.0108	14	.1505
8	43.50	44.00	43.75	6	.0645	20	.2151
9	44.00	44.50	44.25	0	.0000	20	.2151
10	44.50	45.00	44.75	10	.1075	30	.3226
11	45.00	45.50	45.25	11	.1183	41	.4409
12	45.50	46.00	45.75	12	.1290	53	.5699
13	46.00	46.50	46.25	19	.2043	72	.7742
14	46.50	47.00	46.75	6	.0645	78	.8387
15	47.00	47.50	47.25	7	.0753	85	.9140
16	47.50	48.00	47.75	1	.0108	86	.9247
17	48.00	48.50	48.25	0	.0000	86	.9247
18	48.50	49.00	48.75	3	.0323	89	.9570
19	49.00	49.50	49.25	4	.0430	93	1.0000
20	49.50	50.00	49.75	0	.0000	93	1.0000
above	50.00			0	.0000	93	1.0000

Mean = 45.4548 Standard Deviation = 1.99333 Median = 45.8

TABLE A-2. Frequency Tabulation for JP-8 Density (Refer to Fig. 2)

Frequency Tabulation

Class	Lower Limit	Upper Limit	Midpoint	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
at or below		.770		0	.0000	0	.0000
1	.770	.773	.772	0	.0000	0	.0000
2	.773	.776	.775	0	.0000	0	.0000
3	.776	.779	.778	0	.0000	0	.0000
4	.779	.782	.781	4	.0430	4	.0430
5	.782	.785	.784	3	.0323	7	.0753
6	.785	.788	.787	0	.0000	7	.0753
7	.788	.791	.790	5	.0538	12	.1290
8	.791	.794	.793	9	.0968	21	.2258
9	.794	.797	.796	24	.2581	45	.4839
10	.797	.800	.799	14	.1505	59	.6344
11	.800	.803	.802	14	.1505	73	.7849
12	.803	.806	.805	3	.0323	76	.8172
13	.806	.809	.807	3	.0323	79	.8495
14	.809	.812	.811	4	.0430	83	.8925
15	.812	.815	.813	2	.0215	85	.9140
16	.815	.818	.817	3	.0323	88	.9462
17	.818	.821	.819	5	.0538	93	1.0000
18	.821	.824	.823	0	.0000	93	1.0000
19	.824	.827	.825	0	.0000	93	1.0000
20	.827	.830	.829	0	.0000	93	1.0000
above	.830			0	.0000	93	1.0000

Mean = 0.799462 Standard Deviation = 9.02961E-3 Median = 0.798

TABLE A-3. Frequency Tabulation for JP-8 Flash Point (Refer to Fig. 3)

Frequency Tabulation

Class	Lower Limit	Upper Limit	Midpoint	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
at or below		36.00		1	.0108	1	.0108
1	36.00	37.00	36.50	1	.0108	2	.0215
2	37.00	38.00	37.50	3	.0323	5	.0538
3	38.00	39.00	38.50	8	.0860	13	.1398
4	39.00	40.00	39.50	0	.0000	13	.1398
5	40.00	41.00	40.50	13	.1398	26	.2796
6	41.00	42.00	41.50	4	.0430	30	.3226
7	42.00	43.00	42.50	10	.1075	40	.4301
8	43.00	44.00	43.50	7	.0753	47	.5054
9	44.00	45.00	44.50	2	.0215	49	.5269
10	45.00	46.00	45.50	5	.0538	54	.5806
11	46.00	47.00	46.50	2	.0215	56	.6022
12	47.00	48.00	47.50	4	.0430	60	.6452
13	48.00	49.00	48.50	7	.0753	67	.7204
14	49.00	50.00	49.50	2	.0215	69	.7419
15	50.00	51.00	50.50	12	.1290	81	.8710
16	51.00	52.00	51.50	4	.0430	85	.9140
17	52.00	53.00	52.50	4	.0430	89	.9570
18	53.00	54.00	53.50	2	.0215	91	.9785
19	54.00	55.00	54.50	0	.0000	91	.9785
20	55.00	56.00	55.50	0	.0000	91	.9785
21	56.00	57.00	56.50	1	.0108	92	.9892
22	57.00	58.00	57.50	0	.0000	92	.9892
23	58.00	59.00	58.50	0	.0000	92	.9892
24	59.00	60.00	59.50	0	.0000	92	.9892
25	60.00	61.00	60.50	1	.0108	93	1.0000
above	61.00			0	.0000	93	1.0000

Mean = 45.6452   Standard Deviation = 5.20168   Median = 44

TABLE A-4. Frequency Tabulation for JP-8 Distillation (Refer to Fig. 4)

Frequency Tabulation

Class	Lower Limit	Upper Limit	Midpoint	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
at or below		143.50		0	.0000	0	.0000
1	143.50	144.50	144.00	3	.0323	3	.0323
2	144.50	145.50	145.00	1	.0108	4	.0430
3	145.50	146.50	146.00	0	.0000	4	.0430
4	146.50	147.50	147.00	1	.0108	5	.0538
5	147.50	148.50	148.00	3	.0323	8	.0860
6	148.50	149.50	149.00	6	.0645	14	.1505
7	149.50	150.50	150.00	4	.0430	18	.1935
8	150.50	151.50	151.00	7	.0753	25	.2688
9	151.50	152.50	152.00	2	.0215	27	.2903
10	152.50	153.50	153.00	4	.0430	31	.3333
11	153.50	154.50	154.00	8	.0860	39	.4194
12	154.50	155.50	155.00	4	.0430	43	.4624
13	155.50	156.50	156.00	4	.0430	47	.5054
14	156.50	157.50	157.00	3	.0323	50	.5376
15	157.50	158.50	158.00	3	.0323	53	.5699
16	158.50	159.50	159.00	2	.0215	55	.5914
17	159.50	160.50	160.00	3	.0323	58	.6237
18	160.50	161.50	161.00	4	.0430	62	.6667
19	161.50	162.50	162.00	1	.0108	63	.6774
20	162.50	163.50	163.00	8	.0860	71	.7634
21	163.50	164.50	164.00	5	.0538	76	.8172
22	164.50	165.50	165.00	1	.0108	77	.8280
23	165.50	166.50	166.00	3	.0323	80	.8602
24	166.50	167.50	167.00	4	.0430	84	.9032
25	167.50	168.50	168.00	2	.0215	86	.9247
26	168.50	169.50	169.00	2	.0215	88	.9462
27	169.50	170.50	170.00	2	.0215	90	.9677
28	170.50	171.50	171.00	0	.0000	90	.9677
29	171.50	172.50	172.00	2	.0215	92	.9892
30	172.50	173.50	173.00	0	.0000	92	.9892
31	173.50	174.50	174.00	1	.0108	93	1.0000
above	174.50			0	.0000	93	1.0000

Mean = 157.495 Standard Deviation = 7.35974 Median = 156

TABLE A-5. Frequency Tabulation for JP-8 Distillation, 10% Recovered (Refer to Fig. 5)

Frequency Tabulation

Class	Lower Limit	Upper Limit	Midpoint	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
at or below		161.50		0	.0000	0	.0000
1	161.50	162.50	162.00	2	.0215	2	.0215
2	162.50	163.50	163.00	0	.0000	2	.0215
3	163.50	164.50	164.00	0	.0000	2	.0215
4	164.50	165.50	165.00	1	.0108	3	.0323
5	165.50	166.50	166.00	3	.0323	6	.0645
6	166.50	167.50	167.00	5	.0538	11	.1183
7	167.50	168.50	168.00	2	.0215	13	.1398
8	168.50	169.50	169.00	1	.0108	14	.1505
9	169.50	170.50	170.00	2	.0215	16	.1720
10	170.50	171.50	171.00	4	.0430	20	.2151
11	171.50	172.50	172.00	7	.0753	27	.2903
12	172.50	173.50	173.00	10	.1075	37	.3978
13	173.50	174.50	174.00	6	.0645	43	.4624
14	174.50	175.50	175.00	3	.0323	46	.4946
15	175.50	176.50	176.00	6	.0645	52	.5591
16	176.50	177.50	177.00	5	.0538	57	.6129
17	177.50	178.50	178.00	4	.0430	61	.6559
18	178.50	179.50	179.00	9	.0968	70	.7527
19	179.50	180.50	180.00	4	.0430	74	.7957
20	180.50	181.50	181.00	5	.0538	79	.8495
21	181.50	182.50	182.00	3	.0323	82	.8817
22	182.50	183.50	183.00	3	.0323	85	.9140
23	183.50	184.50	184.00	2	.0215	87	.9355
24	184.50	185.50	185.00	0	.0000	87	.9355
25	185.50	186.50	186.00	0	.0000	87	.9355
26	186.50	187.50	187.00	2	.0215	89	.9570
27	187.50	188.50	188.00	2	.0215	91	.9785
28	188.50	189.50	189.00	1	.0108	92	.9892
29	189.50	190.50	190.00	0	.0000	92	.9892
30	190.50	191.50	191.00	1	.0108	93	1.0000
above	191.50			C	.0000	93	1.0000

Mean = 175.656 Standard Deviation = 6.06396 Median = 176

TABLE A-6. Frequency Tabulation for JP-8 Distillation, 50% Recovered (Refer to Fig. 6)

Frequency Tabulation

Class	Lower Limit	Upper Limit	Midpoint	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
at or below		178.50		0	.0000	0	.0000
1	178.50	179.50	179.00	1	.0108	1	.0108
2	179.50	180.50	180.00	0	.0000	1	.0108
3	180.50	181.50	181.00	0	.0000	1	.0108
4	181.50	182.50	182.00	0	.0000	1	.0108
5	182.50	183.50	183.00	1	.0108	2	.0215
6	183.50	184.50	184.00	0	.0000	2	.0215
7	184.50	185.50	185.00	1	.0108	3	.0323
8	185.50	186.50	186.00	2	.0215	5	.0538
9	186.50	187.50	187.00	2	.0215	7	.0753
10	187.50	188.50	188.00	1	.0108	8	.0860
11	188.50	189.50	189.00	1	.0108	9	.0968
12	189.50	190.50	190.00	1	.0108	10	.1075
13	190.50	191.50	191.00	0	.0000	10	.1075
14	191.50	192.50	192.00	3	.0323	13	.1398
15	192.50	193.50	193.00	2	.0215	15	.1613
16	193.50	194.50	194.00	4	.0430	19	.2043
17	194.50	195.50	195.00	4	.0430	23	.2473
18	195.50	196.50	196.00	3	.0323	26	.2796
19	196.50	197.50	197.00	1	.0108	27	.2903
20	197.50	198.50	198.00	5	.0538	32	.3441
21	198.50	199.50	199.00	3	.0323	35	.3763
22	199.50	200.50	200.00	7	.0753	42	.4516
23	200.50	201.50	201.00	3	.0323	45	.4839
24	201.50	202.50	202.00	12	.1290	57	.6129
25	202.50	203.50	203.00	6	.0645	63	.6774
26	203.50	204.50	204.00	5	.0538	68	.7312
27	204.50	205.50	205.00	1	.0108	69	.7419
28	205.50	206.50	206.00	5	.0538	74	.7957
29	206.50	207.50	207.00	3	.0323	77	.8280
30	207.50	208.50	208.00	2	.0215	79	.8495
31	208.50	209.50	209.00	3	.0323	82	.8817
32	209.50	210.50	210.00	1	.0108	83	.8925
33	210.50	211.50	211.00	1	.0108	84	.9032
34	211.50	212.50	212.00	3	.0323	87	.9355
35	212.50	213.50	213.00	1	.0108	88	.9462
36	213.50	214.50	214.00	1	.0108	89	.9570
37	214.50	215.50	215.00	0	.0000	89	.9570
38	215.50	216.50	216.00	3	.0323	92	.9892
39	216.50	217.50	217.00	0	.0000	92	.9892
40	217.50	218.50	218.00	0	.0000	92	.9892
41	218.50	219.50	219.00	0	.0000	92	.9892
42	219.50	220.50	220.00	0	.0000	92	.9892
43	220.50	221.50	221.00	0	.0000	92	.9892
44	221.50	222.50	222.00	1	.0108	93	1.0000
above	222.50			0	.0000	93	1.0000

Mean = 200.731 Standard Deviation = 7.93471 Median = 202

TABLE A-7. Frequency Tabulation for JP-8 Distillation, 90% Recovered (Refer to Fig. 7)

Frequency Tabulation

Class	Lower Limit	Upper Limit	Midpoint	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
at or below		215.50		0	.0000	0	.0000
1	215.50	216.50	216.00	2	.0215	2	.0215
2	216.50	217.50	217.00	0	.0000	2	.0215
3	217.50	218.50	218.00	0	.0000	2	.0215
4	218.50	219.50	219.00	3	.0323	5	.0538
5	219.50	220.50	220.00	1	.0108	6	.0645
6	220.50	221.50	221.00	2	.0215	8	.0860
7	221.50	222.50	222.00	2	.0215	10	.1075
8	222.50	223.50	223.00	2	.0215	12	.1290
9	223.50	224.50	224.00	3	.0323	15	.1613
10	224.50	225.50	225.00	4	.0430	19	.2043
11	225.50	226.50	226.00	4	.0430	23	.2473
12	226.50	227.50	227.00	4	.0430	27	.2903
13	227.50	228.50	228.00	0	.0000	27	.2903
14	228.50	229.50	229.00	2	.0215	29	.3118
15	229.50	230.50	230.00	1	.0108	30	.3226
16	230.50	231.50	231.00	1	.0108	31	.3333
17	231.50	232.50	232.00	2	.0215	33	.3548
18	232.50	233.50	233.00	0	.0000	33	.3548
19	233.50	234.50	234.00	5	.0538	38	.4086
20	234.50	235.50	235.00	1	.0108	39	.4194
21	235.50	236.50	236.00	4	.0430	43	.4624
22	236.50	237.50	237.00	7	.0753	50	.5376
23	237.50	238.50	238.00	10	.1075	60	.6452
24	238.50	239.50	239.00	5	.0538	65	.6989
25	239.50	240.50	240.00	3	.0323	68	.7312
26	240.50	241.50	241.00	1	.0108	69	.7419
27	241.50	242.50	242.00	4	.0430	73	.7849
28	242.50	243.50	243.00	2	.0215	75	.8065
29	243.50	244.50	244.00	2	.0215	77	.8280
30	244.50	245.50	245.00	1	.0108	78	.8387
31	245.50	246.50	246.00	3	.0323	81	.8710
32	246.50	247.50	247.00	1	.0108	82	.8817
33	247.50	248.50	248.00	2	.0215	84	.9032
34	248.50	249.50	249.00	3	.0323	87	.9355
35	249.50	250.50	250.00	2	.0215	89	.9570
36	250.50	251.50	251.00	0	.0000	89	.9570
37	251.50	252.50	252.00	1	.0108	90	.9677
38	252.50	253.50	253.00	2	.0215	92	.9892
39	253.50	254.50	254.00	0	.0000	92	.9892
40	254.50	255.50	255.00	0	.0000	92	.9892
41	255.50	256.50	256.00	1	.0108	93	1.0000
above	256.50			0	.0000	93	1.0000

Mean = 235.28 Standard Deviation = 9.53525 Median = 237

TABLE A-8. Frequency Tabulation for JP-8 Distillation, End Point (Refer to Fig. 8)

Frequency Tabulation

Class	Lower Limit	Upper Limit	Midpoint	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
at or below		225.00		0	.0000	0	.0000
1	225.00	230.00	227.50	0	.0000	0	.0000
2	230.00	235.00	232.50	2	.0215	2	.0215
3	235.00	240.00	237.50	2	.0215	4	.0430
4	240.00	245.00	242.50	10	.1075	14	.1505
5	245.00	250.00	247.50	10	.1075	24	.2581
6	250.00	255.00	252.50	17	.1828	41	.4409
7	255.00	260.00	257.50	13	.1398	54	.5806
8	260.00	265.00	262.50	15	.1613	69	.7419
9	265.00	270.00	267.50	11	.1183	80	.8602
10	270.00	275.00	272.50	7	.0753	87	.9355
11	275.00	280.00	277.50	4	.0430	91	.9785
12	280.00	285.00	282.50	1	.0108	92	.9392
13	285.00	290.00	287.50	0	.0000	92	.9892
14	290.00	295.00	292.50	0	.0000	92	.9892
15	295.00	300.00	297.50	1	.0108	93	1.0000
16	300.00	305.00	302.50	0	.0000	93	1.0000
above	305.00			0	.0000	93	1.0000

Mean = 257.828   Standard Deviation = 11.484   Median = 257

TABLE A-9. Frequency Tabulation for JP-8 Cetane Number (Refer to Fig. 9)

Frequency Tabulation

Class	Lower Limit	Upper Limit	Midpoint	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
at or below		37.50		0	.0000	0	.0000
1	37.50	38.50	38.00	1	.0108	1	.0108
2	38.50	39.50	39.00	0	.0000	1	.0108
3	39.50	40.50	40.00	2	.0215	3	.0323
4	40.50	41.50	41.00	1	.0108	4	.0430
5	41.50	42.50	42.00	7	.0753	11	.1183
6	42.50	43.50	43.00	6	.0645	17	.1828
7	43.50	44.50	44.00	16	.1720	33	.3548
8	44.50	45.50	45.00	24	.2581	57	.6129
9	45.50	46.50	46.00	18	.1935	75	.8065
10	46.50	47.50	47.00	14	.1505	89	.9570
11	47.50	48.50	48.00	3	.0323	92	.9892
12	48.50	49.50	49.00	0	.0000	92	.9892
13	49.50	50.50	50.00	0	.0000	92	.9892
14	50.50	51.50	51.00	0	.0000	92	.9892
15	51.50	52.50	52.00	1	.0108	93	1.0000
above	52.50			0	.0000	93	1.0000

Mean = 44.914   Standard Deviation = 1.99813   Median = 45

TABLE A-10. Frequency Tabulation for JP-8 Cetane Index (Refer to Fig. 10)

Frequency Tabulation

Class	Lower Limit	Upper Limit	Midpoint	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
at or below		32.00		0	.0000	0	.0000
1	32.00	33.00	32.50	0	.0000	0	.0000
2	33.00	34.00	33.50	1	.0108	1	.0108
3	34.00	35.00	34.50	0	.0000	1	.0108
4	35.00	36.00	35.50	0	.0000	1	.0108
5	36.00	37.00	36.50	0	.0000	1	.0108
6	37.00	38.00	37.50	0	.0000	1	.0108
7	38.00	39.00	38.50	0	.0000	1	.0108
8	39.00	40.00	39.50	2	.0215	3	.0323
9	40.00	41.00	40.50	2	.0215	5	.0538
10	41.00	42.00	41.50	5	.0538	10	.1075
11	42.00	43.00	42.50	4	.0430	14	.1505
12	43.00	44.00	43.50	11	.1183	25	.2688
13	44.00	45.00	44.50	23	.2473	48	.5161
14	45.00	46.00	45.50	26	.2796	74	.7957
15	46.00	47.00	46.50	15	.1613	89	.9570
16	47.00	48.00	47.50	4	.0430	93	1.0000
17	48.00	49.00	48.50	0	.0000	93	1.0000
18	49.00	50.00	49.50	0	.0000	93	1.0000
above	50.00			0	.0000	93	1.0000

Mean = 45.0538 Standard Deviation = 2.07661 Median = 45

TABLE A-11. Frequency Tabulation for JP-8 Four Variable Equation Cetane Index (Refer to Fig. 11)

Frequency Tabulation

Class	Lower Limit	Upper Limit	Midpoint	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
at or below		36.00		0	.0000	0	.0000
1	36.00	37.00	36.50	1	.0108	1	.0108
2	37.00	38.00	37.50	0	.0000	1	.0108
3	38.00	39.00	38.50	0	.0000	1	.0108
4	39.00	40.00	39.50	0	.0000	1	.0108
5	40.00	41.00	40.50	1	.0108	2	.0215
6	41.00	42.00	41.50	2	.0215	4	.0430
7	42.00	43.00	42.50	6	.0645	10	.1075
8	43.00	44.00	43.50	4	.0430	14	.1505
9	44.00	45.00	44.50	5	.0538	19	.2043
10	45.00	46.00	45.50	14	.1505	33	.3548
11	46.00	47.00	46.50	19	.2043	52	.5591
12	47.00	48.00	47.50	19	.2043	71	.7634
13	48.00	49.00	48.50	18	.1935	89	.9570
14	49.00	50.00	49.50	4	.0430	93	1.0000
15	50.00	51.00	50.50	0	.0000	93	1.0000
above	51.00			0	.0000	93	1.0000

Mean = 46.7957 Standard Deviation = 2.27252 Median = 47

TABLE A-12. Frequency Tabulation for JP-8 Kinematic Viscosity at 40°C (Refer to Fig. 14)

Frequency Tabulation

Class	Lower Limit	Upper Limit	Midpoint	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
at or below		1.00		0	.0000	0	.0000
1	1.00	1.04	1.02	0	.0000	0	.0000
2	1.04	1.08	1.06	3	.0323	3	.0323
3	1.08	1.12	1.10	6	.0645	9	.0968
4	1.12	1.16	1.14	11	.1183	20	.2151
5	1.16	1.20	1.18	8	.0860	28	.3011
6	1.20	1.24	1.22	19	.2043	47	.5054
7	1.24	1.28	1.26	14	.1505	61	.6559
8	1.28	1.32	1.30	16	.1720	77	.8280
9	1.32	1.36	1.34	3	.0323	80	.8602
10	1.36	1.40	1.38	3	.0323	83	.8925
11	1.40	1.44	1.42	5	.0538	88	.9462
12	1.44	1.48	1.46	1	.0108	89	.9570
13	1.48	1.52	1.50	3	.0323	92	.9892
14	1.52	1.56	1.54	0	.0000	92	.9892
15	1.56	1.60	1.58	1	.0108	93	1.0000
above	1.60			0	.0000	93	1.0000

Mean = 1.25462   Standard Deviation = 0.106726   Median = 1.24

TABLE A-13. Frequency Tabulation for JP-8 Kinematic Viscosity at 70°C (Refer to Fig. 15)

Frequency Tabulation

Class	Lower Limit	Upper Limit	Midpoint	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
at or below		.730		0	.0000	0	.0000
1	.730	.750	.740	2	.0215	2	.0215
2	.750	.770	.760	0	.0000	2	.0215
3	.770	.790	.780	6	.0645	8	.0860
4	.790	.810	.800	7	.0753	15	.1613
5	.810	.830	.820	9	.0968	24	.2581
6	.830	.850	.840	9	.0968	33	.3548
7	.850	.870	.860	16	.1720	49	.5269
8	.870	.890	.880	12	.1290	61	.6559
9	.890	.910	.900	11	.1183	72	.7742
10	.910	.930	.920	8	.0860	80	.8602
11	.930	.950	.940	4	.0430	84	.9032
12	.950	.970	.960	1	.0108	85	.9140
13	.970	.990	.980	4	.0430	89	.9570
14	.990	1.010	1.000	0	.0000	89	.9570
15	1.010	1.030	1.020	3	.0323	92	.9892
16	1.030	1.050	1.040	0	.0000	92	.9892
17	1.050	1.070	1.060	1	.0108	93	1.0000
18	1.070	1.090	1.080	0	.0000	93	1.0000
19	1.090	1.110	1.100	0	.0000	93	1.0000
20	1.110	1.130	1.120	0	.0000	93	1.0000
above	1.130			0	.0000	93	1.0000

Mean = 0.875484   Standard Deviation = 0.0612819   Median = 0.87

TABLE A-14. Frequency Tabulation for JP-8 Kinematic Viscosity at -20°C (Refer to Fig. 16)

Frequency Tabulation

Class	Lower Limit	Upper Limit	Midpoint	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
at or below		2.50		0	.0000	0	.0000
1	2.50	2.75	2.63	1	.0108	1	.0108
2	2.75	3.00	2.88	1	.0108	2	.0215
3	3.00	3.25	3.13	4	.0430	6	.0645
4	3.25	3.50	3.38	16	.1720	22	.2366
5	3.50	3.75	3.63	6	.0645	28	.3011
6	3.75	4.00	3.88	21	.2258	49	.5269
7	4.00	4.25	4.13	11	.1183	60	.6452
8	4.25	4.50	4.38	15	.1613	75	.8065
9	4.50	4.75	4.63	6	.0645	81	.8710
10	4.75	5.00	4.88	4	.0430	85	.9140
11	5.00	5.25	5.13	2	.0215	87	.9355
12	5.25	5.50	5.38	1	.0108	88	.9462
13	5.50	5.75	5.63	2	.0215	90	.9677
14	5.75	6.00	5.88	1	.0108	91	.9785
15	6.00	6.25	6.13	0	.0000	91	.9785
16	6.25	6.50	6.38	2	.0215	93	1.0000
17	6.50	6.75	6.63	0	.0000	93	1.0000
18	6.75	7.00	6.88	0	.0000	93	1.0000
19	7.00	7.25	7.13	0	.0000	93	1.0000
20	7.25	7.50	7.38	0	.0000	93	1.0000
above	7.50			0	.0000	93	1.0000

Mean = 4.08602 Standard Deviation = 0.70858 Median = 4

TABLE A-15. Frequency Tabulation for JP-8 Sulfur Content (Refer to Fig. 17)

Frequency Tabulation

Class	Lower Limit	Upper Limit	Midpoint	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
at or below		.0000		0	.0000	0	.000
1	.0000	.0200	.0100	32	.3441	32	.344
2	.0200	.0400	.0300	7	.0753	39	.419
3	.0400	.0600	.0500	12	.1290	51	.548
4	.0600	.0800	.0700	9	.0968	60	.645
5	.0800	.1000	.0900	8	.0860	68	.731
6	.1000	.1200	.1100	5	.0538	73	.785
7	.1200	.1400	.1300	6	.0645	79	.849
8	.1400	.1600	.1500	7	.0753	86	.925
9	.1600	.1800	.1700	4	.0430	90	.968
10	.1800	.2000	.1900	1	.0108	91	.978
11	.2000	.2200	.2100	0	.0000	91	.978
12	.2200	.2400	.2300	1	.0108	92	.989
13	.2400	.2600	.2500	0	.0000	92	.989
14	.2600	.2800	.2700	1	.0108	93	1.000
above	.2800			0	.0000	93	1.000

Mean = 0.0710753 Standard Deviation = 0.0613341 Median = 0.06

TABLE A-16. Frequency Tabulation for JP-8 Net Heat of Combustion, Btu/lb (Refer to Fig. 18)

Frequency Tabulation

Class	Lower Limit	Upper Limit	Midpoint	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
at or below		18300.00		0	.0000	0	.0000
1	18300.00	18320.00	18310.00	0	.0000	0	.0000
2	18320.00	18340.00	18330.00	0	.0000	0	.0000
3	18340.00	18360.00	18350.00	0	.0000	0	.0000
4	18360.00	18380.00	18370.00	1	.0108	1	.0108
5	18380.00	18400.00	18390.00	3	.0323	4	.0430
6	18400.00	18420.00	18410.00	5	.0538	9	.0968
7	18420.00	18440.00	18430.00	7	.0753	16	.1720
8	18440.00	18460.00	18450.00	5	.0538	21	.2258
9	18460.00	18480.00	18470.00	9	.0968	30	.3226
10	18480.00	18500.00	18490.00	19	.2043	49	.5269
11	18500.00	18520.00	18510.00	13	.1398	62	.6667
12	18520.00	18540.00	18530.00	17	.1828	79	.8495
13	18540.00	18560.00	18550.00	5	.0538	84	.9032
14	18560.00	18580.00	18570.00	4	.0430	88	.9462
15	18580.00	18600.00	18590.00	4	.0430	92	.9892
16	18600.00	18620.00	18610.00	1	.0108	93	1.0000
17	18620.00	18640.00	18630.00	0	.0000	93	1.0000
18	18640.00	18660.00	18650.00	0	.0000	93	1.0000
19	18660.00	18680.00	18670.00	0	.0000	93	1.0000
20	18680.00	18700.00	18690.00	0	.0000	93	1.0000
above	18700.00			0	.0000	93	1.0000

Mean = 18494.9   Standard Deviation = 50.9252   Median = 18499

TABLE A-17. Frequency Tabulation for JP-8 Net Heat of Combustion, Btu/gal. (Refer to Fig. 17)

Frequency Tabulation

Class	Lower Limit	Upper Limit	Midpoint	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
at or below		120000.00		0	.0000	0	.0000
1	120000.00	120500.00	120250.00	1	.0108	1	.0108
2	120500.00	121000.00	120750.00	3	.0323	4	.0430
3	121000.00	121500.00	121250.00	4	.0430	8	.0860
4	121500.00	122000.00	121750.00	3	.0323	11	.1183
5	122000.00	122500.00	122250.00	16	.1720	27	.2903
6	122500.00	123000.00	122750.00	24	.2581	51	.5484
7	123000.00	123500.00	123250.00	11	.1183	62	.6667
8	123500.00	124000.00	123750.00	10	.1075	72	.7742
9	124000.00	124500.00	124250.00	7	.0753	79	.8495
10	124500.00	125000.00	124750.00	4	.0430	83	.8925
11	125000.00	125500.00	125250.00	5	.0538	88	.9462
12	125500.00	126000.00	125750.00	2	.0215	90	.9677
13	126000.00	126500.00	126250.00	3	.0323	93	1.0000
14	126500.00	127000.00	126750.00	0	.0000	93	1.0000
above	127000.00			0	.0000	93	1.0000

Mean = 123138   Standard Deviation = 1264.58   Median = 122832

TABLE A-18. Frequency Tabulation for JP-8 Aromatics (Refer to Fig. 20)

Frequency Tabulation

Class	Lower Limit	Upper Limit	Midpoint	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
at or below		10.00		0	.0000	0	.0000
1	10.00	10.50	10.25	0	.0000	0	.0000
2	10.50	11.00	10.75	1	.0108	1	.0108
3	11.00	11.50	11.25	1	.0108	2	.0215
4	11.50	12.00	11.75	2	.0215	4	.0430
5	12.00	12.50	12.25	0	.0000	4	.0430
6	12.50	13.00	12.75	3	.0323	7	.0753
7	13.00	13.50	13.25	1	.0108	8	.0860
8	13.50	14.00	13.75	2	.0215	10	.1075
9	14.00	14.50	14.25	1	.0108	11	.1183
10	14.50	15.00	14.75	7	.0753	18	.1935
11	15.00	15.50	15.25	6	.0645	24	.2581
12	15.50	16.00	15.75	8	.0860	32	.3441
13	16.00	16.50	16.25	10	.1075	42	.4516
14	16.50	17.00	16.75	16	.1720	58	.6237
15	17.00	17.50	17.25	10	.1075	68	.7312
16	17.50	18.00	17.75	3	.0323	71	.7634
17	18.00	18.50	18.25	2	.0215	73	.7849
18	18.50	19.00	18.75	10	.1075	83	.8925
19	19.00	19.50	19.25	0	.0000	83	.8925
20	19.50	20.00	19.75	6	.0645	89	.9570
21	20.00	20.50	20.25	2	.0215	91	.9785
22	20.50	21.00	20.75	1	.0108	92	.9892
23	21.00	21.50	21.25	1	.0108	93	1.0000
24	21.50	22.00	21.75	0	.0000	93	1.0000
above	22.00			0	.0000	93	1.0000

Mean = 16.6989 Standard Deviation = 2.12012 Median = 16.9

TABLE A-19. Frequency Tabulation for JP-8 Olefins (Refer to Fig. 21)

Frequency Tabulation

Class	Lower Limit	Upper Limit	Midpoint	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
at or below		.000		0	.0000	0	.0000
1	.000	.200	.100	9	.0968	9	.0968
2	.200	.400	.300	9	.0968	18	.1935
3	.400	.600	.500	8	.0860	26	.2796
4	.600	.800	.700	4	.0430	30	.3226
5	.800	1.000	.900	34	.3656	64	.6882
6	1.000	1.200	1.100	5	.0538	69	.7419
7	1.200	1.400	1.300	3	.0323	72	.7742
8	1.400	1.600	1.500	6	.0645	78	.8387
9	1.600	1.800	1.700	9	.0968	87	.9355
10	1.800	2.000	1.900	2	.0215	89	.9570
11	2.000	2.200	2.100	1	.0108	90	.9677
12	2.200	2.400	2.300	0	.0000	90	.9677
13	2.400	2.600	2.500	2	.0215	92	.9892
14	2.600	2.800	2.700	0	.0000	92	.9892
15	2.800	3.000	2.900	0	.0000	92	.9892
16	3.000	3.200	3.100	0	.0000	92	.9892
17	3.200	3.400	3.300	0	.0000	92	.9892
18	3.400	3.600	3.500	1	.0108	93	1.0000
19	3.600	3.800	3.700	0	.0000	93	1.0000
20	3.800	4.000	3.900	0	.0000	93	1.0000
above	4.000			0	.0000	93	1.0000

Mean = 1.01613 Standard Deviation = 0.604025 Median = 1

TABLE A-20. Frequency Tabulation for JP-8 Hydrogen Content (Refer to Fig. 21)

Frequency Tabulation

Class	Lower Limit	Upper Limit	Midpoint	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
at or below		13.20		0	.0000	0	.0000
1	13.20	13.30	13.25	0	.0000	0	.0000
2	13.30	13.40	13.35	1	.0108	1	.0108
3	13.40	13.50	13.45	3	.0323	4	.0430
4	13.50	13.60	13.55	3	.0323	7	.0753
5	13.60	13.70	13.65	13	.1398	20	.2151
6	13.70	13.80	13.75	25	.2688	45	.4839
7	13.80	13.90	13.85	13	.1398	58	.6237
8	13.90	14.00	13.95	19	.2043	77	.8280
9	14.00	14.10	14.05	11	.1183	88	.9462
10	14.10	14.20	14.15	3	.0323	91	.9785
11	14.20	14.30	14.25	1	.0108	92	.9892
12	14.30	14.40	14.35	1	.0108	93	1.0000
13	14.40	14.50	14.45	0	.0000	93	1.0000
14	14.50	14.60	14.55	0	.0000	93	1.0000
above	14.60			0	.0000	93	1.0000

Mean = 13.8806 Standard Deviation = 0.181933 Median = 13.9

TABLE A-21. Frequency Tabulation for JP-5 API Gravity (Refer to Fig. 23)

Frequency Tabulation

Class	Lower Limit	Upper Limit	Midpoint	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
at or below		37.00		0	.0000	0	.0000
1	37.00	37.50	37.25	0	.0000	0	.0000
2	37.50	38.00	37.75	1	.0159	1	.0159
3	38.00	38.50	38.25	8	.1270	9	.1429
4	38.50	39.00	38.75	8	.1270	17	.2698
5	39.00	39.50	39.25	2	.0317	19	.3016
6	39.50	40.00	39.75	2	.0317	21	.3333
7	40.00	40.50	40.25	4	.0635	25	.3968
8	40.50	41.00	40.75	4	.0635	29	.4603
9	41.00	41.50	41.25	8	.1270	37	.5873
10	41.50	42.00	41.75	6	.0952	43	.6825
11	42.00	42.50	42.25	4	.0635	47	.7460
12	42.50	43.00	42.75	4	.0635	51	.8095
13	43.00	43.50	43.25	6	.0952	57	.9048
14	43.50	44.00	43.75	0	.0000	57	.9048
15	44.00	44.50	44.25	0	.0000	57	.9048
16	44.50	45.00	44.75	0	.0000	57	.9048
17	45.00	45.50	45.25	3	.0476	60	.9524
18	45.50	46.00	45.75	3	.0476	63	1.0000
19	46.00	46.50	46.25	0	.0000	63	1.0000
20	46.50	47.00	46.75	0	.0000	63	1.0000
above	47.00			0	.0000	63	1.0000

Mean = 41.1381 Standard Deviation = 2.16991 Median = 41.2

TABLE A-22. Frequency Tabulation for JP-5 Density (Refer to Fig. 24)

Frequency Tabulation

Class	Lower Limit	Upper Limit	Midpoint	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
at or below		.780		0	.0000	0	.0000
1	.780	.783	.781	0	.0000	0	.0000
2	.783	.785	.784	0	.0000	0	.0000
3	.785	.788	.786	0	.0000	0	.0000
4	.788	.790	.789	0	.0000	0	.0000
5	.790	.793	.791	0	.0000	0	.0000
6	.793	.795	.794	0	.0000	0	.0000
7	.795	.798	.796	1	.0159	1	.0159
8	.798	.800	.799	5	.0794	6	.0952
9	.800	.803	.801	0	.0000	6	.0952
10	.803	.805	.804	0	.0000	6	.0952
11	.805	.808	.806	0	.0000	6	.0952
12	.808	.810	.809	6	.0952	12	.1905
13	.810	.813	.811	3	.0476	15	.2381
14	.813	.815	.814	4	.0635	19	.3016
15	.815	.818	.816	6	.0952	25	.3968
16	.818	.820	.819	13	.2063	38	.6032
17	.820	.823	.821	1	.0159	39	.6190
18	.823	.825	.824	4	.0635	43	.6825
19	.825	.828	.826	1	.0159	44	.6984
20	.828	.830	.829	4	.0635	48	.7619
21	.830	.833	.831	11	.1746	59	.9365
22	.833	.835	.834	4	.0635	63	1.0000
23	.835	.837	.836	0	.0000	63	1.0000
24	.837	.840	.839	0	.0000	63	1.0000
above	.840			0	.0000	63	1.0000

Mean = 0.819429 Standard Deviation = 0.0102669 Median = 0.819

TABLE 23. Frequency Tabulation for JP-5 Flash Point (Refer to Fig. 25)

Frequency Tabulation

Class	Lower Limit	Upper Limit	Midpoint	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
at or below		52.50		0	.0000	0	.0000
1	52.50	53.50	53.00	1	.0159	1	.0159
2	53.50	54.50	54.00	1	.0159	2	.0317
3	54.50	55.50	55.00	0	.0000	2	.0317
4	55.50	56.50	56.00	0	.0000	2	.0317
5	56.50	57.50	57.00	0	.0000	2	.0317
6	57.50	58.50	58.00	2	.0317	4	.0635
7	58.50	59.50	59.00	5	.0794	9	.1429
8	59.50	60.50	60.00	7	.1111	16	.2540
9	60.50	61.50	61.00	8	.1270	24	.3810
10	61.50	62.50	62.00	14	.2222	38	.6032
11	62.50	63.50	63.00	8	.1270	46	.7302
12	63.50	64.50	64.00	6	.0952	52	.8254
13	64.50	65.50	65.00	3	.0476	55	.8730
14	65.50	66.50	66.00	3	.0476	58	.9206
15	66.50	67.50	67.00	2	.0317	60	.9524
16	67.50	68.50	68.00	3	.0476	63	1.0000
above	68.50			0	.0000	63	1.0000

Mean = 62.1111 Standard Deviation = 2.90223 Median = 62

TABLE A-24. Frequency Tabulation for JP-5 Distillation, 10% Recovered (Refer to Fig. 26)

Frequency Tabulation

Class	Lower Limit	Upper Limit	Midpoint	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
at or below		185.50		0	.0000	0	.0000
1	185.50	186.50	186.00	1	.0159	1	.0159
2	186.50	187.50	187.00	0	.0000	1	.0159
3	187.50	188.50	188.00	1	.0159	2	.0317
4	188.50	189.50	189.00	4	.0635	6	.0952
5	189.50	190.50	190.00	0	.0000	6	.0952
6	190.50	191.50	191.00	2	.0317	8	.1270
7	191.50	192.50	192.00	4	.0635	12	.1905
8	192.50	193.50	193.00	6	.0952	18	.2857
9	193.50	194.50	194.00	11	.1746	29	.4603
10	194.50	195.50	195.00	3	.0476	32	.5079
11	195.50	196.50	196.00	4	.0635	36	.5714
12	196.50	197.50	197.00	6	.0952	42	.6667
13	197.50	198.50	198.00	4	.0635	46	.7302
14	198.50	199.50	199.00	1	.0159	47	.7460
15	199.50	200.50	200.00	6	.0952	53	.8413
16	200.50	201.50	201.00	7	.1111	60	.9524
17	201.50	202.50	202.00	1	.0159	61	.9683
18	202.50	203.50	203.00	2	.0317	63	1.0000
above	203.50			0	.0000	63	1.0000

Mean = 195.698   Standard Deviation = 4.02666   Median = 195

TABLE A-25. Frequency Tabulation for JP-5 Distillation, 50% Recovered (Refer to Fig. 27)

Frequency Tabulation

Class	Lower Limit	Upper Limit	Midpoint	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
at or below		202.50		0	.0000	0	.0000
1	202.50	203.50	203.00	2	.0317	2	.0317
2	203.50	204.50	204.00	1	.0159	3	.0476
3	204.50	205.50	205.00	1	.0159	4	.0635
4	205.50	206.50	206.00	4	.0635	8	.1270
5	206.50	207.50	207.00	1	.0159	9	.1429
6	207.50	208.50	208.00	2	.0317	11	.1746
7	208.50	209.50	209.00	0	.0000	11	.1746
8	209.50	210.50	210.00	0	.0000	11	.1746
9	210.50	211.50	211.00	2	.0317	13	.2063
10	211.50	212.50	212.00	1	.0159	14	.2222
11	212.50	213.50	213.00	4	.0635	18	.2857
12	213.50	214.50	214.00	9	.1429	27	.4286
13	214.50	215.50	215.00	1	.0159	28	.4444
14	215.50	216.50	216.00	3	.0476	31	.4921
15	216.50	217.50	217.00	7	.1111	38	.6032
16	217.50	218.50	218.00	6	.0952	44	.6984
17	218.50	219.50	219.00	13	.2063	57	.9048
18	219.50	220.50	220.00	1	.0159	58	.9206
19	220.50	221.50	221.00	3	.0476	61	.9683
above	221.50			2	.0317	63	1.0000

Mean = 214.889   Standard Deviation = 5.0549   Median = 217

TABLE A-26. Frequency Tabulation for JP-5 Distillation, 90% Recovered (Refer to Fig. 28)

Frequency Tabulation

Class	Lower Limit	Upper Limit	Midpoint	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
at or below		222.50		0	.0000	0	.0000
1	222.50	223.50	223.00	1	.0159	1	.0159
2	223.50	224.50	224.00	1	.0159	2	.0317
3	224.50	225.50	225.00	0	.0000	2	.0317
4	225.50	226.50	226.00	1	.0159	3	.0476
5	226.50	227.50	227.00	0	.0000	3	.0476
6	227.50	228.50	228.00	1	.0159	4	.0635
7	228.50	229.50	229.00	0	.0000	4	.0635
8	229.50	230.50	230.00	1	.0159	5	.0794
9	230.50	231.50	231.00	1	.0159	6	.0952
10	231.50	232.50	232.00	0	.0000	6	.0952
11	232.50	233.50	233.00	3	.0476	9	.1429
12	233.50	234.50	234.00	0	.0000	9	.1429
13	234.50	235.50	235.00	0	.0000	9	.1429
14	235.50	236.50	236.00	1	.0159	10	.1587
15	236.50	237.50	237.00	1	.0159	11	.1746
16	237.50	238.50	238.00	0	.0000	11	.1746
17	238.50	239.50	239.00	2	.0317	13	.2063
18	239.50	240.50	240.00	1	.0159	14	.2222
19	240.50	241.50	241.00	4	.0635	18	.2857
20	241.50	242.50	242.00	13	.2063	31	.4921
21	242.50	243.50	243.00	8	.1270	39	.6190
22	243.50	244.50	244.00	5	.0794	44	.6984
23	244.50	245.50	245.00	3	.0476	47	.7460
24	245.50	246.50	246.00	2	.0317	49	.7778
25	246.50	247.50	247.00	6	.0952	55	.8730
26	247.50	248.50	248.00	1	.0159	56	.8889
27	248.50	249.50	249.00	4	.0635	60	.9524
28	249.50	250.50	250.00	0	.0000	60	.9524
29	250.50	251.50	251.00	0	.0000	60	.9524
30	251.50	252.50	252.00	0	.0000	60	.9524
31	252.50	253.50	253.00	1	.0159	61	.9683
32	253.50	254.50	254.00	1	.0159	62	.9841
33	254.50	255.50	255.00	0	.0000	62	.9841
34	255.50	256.50	256.00	0	.0000	62	.9841
35	256.50	257.50	257.00	1	.0159	63	1.0000
above	257.50			0	.0000	63	1.0000

Mean = 241.952 Standard Deviation = 6.58794 Median = 243

TABLE A-27. Frequency Tabulation for JP-5 Cetane Number (Refer to Fig. 29)

Frequency Tabulation

Class	Lower Limit	Upper Limit	Midpoint	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
at or	below	37.50		0	.0000	0	.000
1	37.50	38.50	38.00	10	.1587	10	.159
2	38.50	39.50	39.00	12	.1905	22	.349
3	39.50	40.50	40.00	1	.0159	23	.365
4	40.50	41.50	41.00	4	.0635	27	.429
5	41.50	42.50	42.00	1	.0159	28	.444
6	42.50	43.50	43.00	6	.0952	34	.540
7	43.50	44.50	44.00	12	.1905	46	.730
8	44.50	45.50	45.00	7	.1111	53	.841
9	45.50	46.50	46.00	3	.0476	56	.889
10	46.50	47.50	47.00	6	.0952	62	.984
11	47.50	48.50	48.00	1	.0159	63	1.000
above	48.50			0	.0000	63	1.000

Mean = 42.2698 Standard Deviation = 3.16842 Median = 43

TABLE A-28. Frequency Tabulation for JP-5 Cetane Index (Refer to Fig. 30)

Frequency Tabulation

Class	Lower Limit	Upper Limit	Midpoint	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
at or	below	36.50		0	.0000	0	.0000
1	36.50	37.50	37.00	1	.0159	1	.0159
2	37.50	38.50	38.00	4	.0635	5	.0794
3	38.50	39.50	39.00	13	.2063	18	.2857
4	39.50	40.50	40.00	5	.0794	23	.3651
5	40.50	41.50	41.00	1	.0159	24	.3810
6	41.50	42.50	42.00	3	.0476	27	.4286
7	42.50	43.50	43.00	[illegible]	.0317	29	.4603
8	43.50	44.50	44.00	9	.1429	38	.6032
9	44.50	45.50	45.00	12	.1905	50	.7937
10	45.50	46.50	46.00	7	.1111	57	.9048
11	46.50	47.50	47.00	5	.0794	62	.9841
12	47.50	48.50	48.00	1	.0159	63	1.0000
above	48.50			0	.0000	63	1.0000

Mean = 42.6984 Standard Deviation = 3.15019 Median = 44

TABLE A-29. Frequency Tabulation for JP-5 Four Variable Equation (Refer to Fig. 31)

Frequency Tabulation

Class	Lower Limit	Upper Limit	Midpoint	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
at or below		36.50		0	.0000	0	.0000
1	36.50	37.50	37.00	1	.0159	1	.0159
2	37.50	38.50	38.00	1	.0159	2	.0317
3	38.50	39.50	39.00	11	.1746	13	.2063
4	39.50	40.50	40.00	9	.1429	22	.3492
5	40.50	41.50	41.00	0	.0000	22	.3492
6	41.50	42.50	42.00	2	.0317	24	.3810
7	42.50	43.50	43.00	2	.0317	26	.4127
8	43.50	44.50	44.00	5	.0794	31	.4921
9	44.50	45.50	45.00	8	.1270	39	.6190
10	45.50	46.50	46.00	10	.1587	49	.7778
11	46.50	47.50	47.00	6	.0952	55	.8730
12	47.50	48.50	48.00	3	.0476	58	.9206
13	48.50	49.50	49.00	4	.0635	62	.9841
14	49.50	50.50	50.00	1	.0159	63	1.0000
above	50.50			0	.0000	63	1.0000

Mean = 43.5873 Standard Deviation = 3.56793 Median = 45

TABLE A-30. Frequency Tabulation for JP-5 Kinematic Viscosity at 40°C (Refer to Fig. 34)

Frequency Tabulation

Class	Lower Limit	Upper Limit	Midpoint	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
at or below		1.28		0	.0000	0	.0000
1	1.28	1.30	1.29	2	.0317	2	.0317
2	1.30	1.32	1.31	1	.0159	3	.0476
3	1.32	1.34	1.33	2	.0317	5	.0794
4	1.34	1.36	1.35	1	.0159	6	.0952
5	1.36	1.38	1.37	1	.0159	7	.1111
6	1.38	1.40	1.39	2	.0317	9	.1429
7	1.40	1.42	1.41	3	.0476	12	.1905
8	1.42	1.44	1.43	2	.0317	14	.2222
9	1.44	1.46	1.45	4	.0635	18	.2857
10	1.46	1.48	1.47	9	.1429	27	.4286
11	1.48	1.50	1.49	3	.0476	30	.4762
12	1.50	1.52	1.51	4	.0635	34	.5397
13	1.52	1.54	1.53	3	.0476	37	.5873
14	1.54	1.56	1.55	6	.0952	43	.6825
15	1.56	1.58	1.57	7	.1111	50	.7937
16	1.58	1.60	1.59	8	.1270	58	.9206
17	1.60	1.62	1.61	2	.0317	60	.9524
18	1.62	1.64	1.63	1	.0159	61	.9683
19	1.64	1.66	1.65	2	.0317	63	1.0000
20	1.66	1.68	1.67	0	.0000	63	1.0000
above	1.68			0	.0000	63	1.0000

Mean = 1.5046 Standard Deviation = 0.0907109 Median = 1.52

TABLE A-31. Frequency Tabulation for JP-5 Kinematic Viscosity at 70°C (Refer to Fig. 35)

Frequency Tabulation

Class	Lower Limit	Upper Limit	Midpoint	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
at or below		.880		0	.0000	0	.0000
1	.880	.890	.885	1	.0159	1	.0159
2	.890	.900	.895	1	.0159	2	.0317
3	.900	.910	.905	1	.0159	3	.0476
4	.910	.920	.915	1	.0159	4	.0635
5	.920	.930	.925	2	.0317	6	.0952
6	.930	.940	.935	1	.0159	7	.1111
7	.940	.950	.945	2	.0317	9	.1429
8	.950	.960	.955	1	.0159	10	.1587
9	.960	.970	.965	3	.0476	13	.2063
10	.970	.980	.975	1	.0159	14	.2222
11	.980	.990	.985	7	.1111	21	.3333
12	.990	1.000	.995	2	.0317	23	.3651
13	1.000	1.010	1.005	7	.1111	30	.4762
14	1.010	1.020	1.015	3	.0476	33	.5238
15	1.020	1.030	1.025	3	.0476	36	.5714
16	1.030	1.040	1.035	5	.0794	41	.6508
17	1.040	1.050	1.045	6	.0952	47	.7460
18	1.050	1.060	1.055	6	.0952	53	.8413
19	1.060	1.070	1.065	5	.0794	58	.9206
20	1.070	1.080	1.075	2	.0317	60	.9524
21	1.080	1.090	1.085	2	.0317	62	.9841
22	1.090	1.100	1.095	0	.0000	62	.9841
23	1.100	1.110	1.105	1	.0159	63	1.0000
24	1.110	1.120	1.115	0	.0000	63	1.0000
above	1.120			0	.0000	63	1.0000

Mean = 1.01556 Standard Deviation = 0.050793 Median = 1.02

TABLE A-32. Frequency Tabulation for JP-5 Sulfur Content (Refer to Fig. 36)

Frequency Tabulation

Class	Lower Limit	Upper Limit	Midpoint	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
at or below		.0000		0	.0000	0	.000
1	.0000	.0200	.0100	13	.2063	13	.206
2	.0200	.0400	.0300	12	.1905	25	.397
3	.0400	.0600	.0500	11	.1746	36	.571
4	.0600	.0800	.0700	2	.0317	38	.603
5	.0800	.1000	.0900	0	.0000	38	.603
6	.1000	.1200	.1100	5	.0794	43	.683
7	.1200	.1400	.1300	0	.0000	43	.683
8	.1400	.1600	.1500	1	.0159	44	.698
9	.1600	.1800	.1700	0	.0000	44	.698
10	.1800	.2000	.1900	0	.0000	44	.698
11	.2000	.2200	.2100	0	.0000	44	.698
12	.2200	.2400	.2300	10	.1587	54	.857
13	.2400	.2600	.2500	6	.0952	60	.952
14	.2600	.2800	.2700	3	.0476	63	1.000
above	.2800			0	.0000	63	1.000

Mean = 0.107143 Standard Deviation = 0.0974254 Median = 0.06

TABLE A-33. Frequency Tabulation for JP-5 Net Heat of Combustion, Btu/lb (Refer to Fig. 37)

Frequency Tabulation

Class	Lower Limit	Upper Limit	Midpoint	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
at or below		18300.00		0	.0000	0	.0000
1	18300.00	18320.00	18310.00	0	.0000	0	.0000
2	18320.00	18340.00	18330.00	1	.0159	1	.0159
3	18340.00	18360.00	18350.00	6	.0952	7	.1111
4	18360.00	18380.00	18370.00	11	.1746	18	.2857
5	18380.00	18400.00	18390.00	5	.0794	23	.3651
6	18400.00	18420.00	18410.00	1	.0159	24	.3810
7	18420.00	18440.00	18430.00	0	.0000	24	.3810
8	18440.00	18460.00	18450.00	2	.0317	26	.4127
9	18460.00	18480.00	18470.00	5	.0794	31	.4921
10	18480.00	18500.00	18490.00	12	.1905	43	.6825
11	18500.00	18520.00	18510.00	6	.0952	49	.7778
12	18520.00	18540.00	18530.00	8	.1270	57	.9048
13	18540.00	18560.00	18550.00	2	.0317	59	.9365
14	18560.00	18580.00	18570.00	3	.0476	62	.9841
15	18580.00	18600.00	18590.00	1	.0159	63	1.0000
above	18600.00			0	.0000	63	1.0000

Mean = 18455.8 Standard Deviation = 73.6589 Median = 18481

TABLE A-34. Frequency Tabulation for JP-5 Net Heat of Combustion, Btu/gal. (Refer to Fig. 38)

Frequency Tabulation

Class	Lower Limit	Upper Limit	Midpoint	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
at or below		123000.00		0	.0000	0	.0000
1	123000.00	123250.00	123125.00	1	.0159	1	.0159
2	123250.00	123500.00	123375.00	1	.0159	2	.0317
3	123500.00	123750.00	123625.00	3	.0476	5	.0794
4	123750.00	124000.00	123875.00	1	.0159	6	.0952
5	124000.00	124250.00	124125.00	0	.0000	6	.0952
6	124250.00	124500.00	124375.00	0	.0000	6	.0952
7	124500.00	124750.00	124625.00	2	.0317	8	.1270
8	124750.00	125000.00	124875.00	4	.0635	12	.1905
9	125000.00	125250.00	125125.00	5	.0794	17	.2698
10	125250.00	125500.00	125375.00	3	.0476	20	.3175
11	125500.00	125750.00	125625.00	3	.0476	23	.3651
12	125750.00	126000.00	125875.00	6	.0952	29	.4603
13	126000.00	126250.00	126125.00	6	.0952	35	.5556
14	126250.00	126500.00	126375.00	7	.1111	42	.6667
15	126500.00	126750.00	126625.00	4	.0635	46	.7302
16	126750.00	127000.00	126875.00	2	.0317	48	.7619
17	127000.00	127250.00	127125.00	6	.0952	54	.8571
18	127250.00	127500.00	127375.00	7	.1111	61	.9683
19	127500.00	127750.00	127625.00	2	.0317	63	1.0000
20	127750.00	128000.00	127875.00	0	.0000	63	1.0000
above	128000.00			0	.0000	63	1.0000

Mean = 125964 Standard Deviation = 1140.42 Median = 126064

TABLE A-35. Frequency Tabulation for JP-5 Aromatics (Refer to Fig. 39)

Frequency Tabulation

Class	Lower Limit	Upper Limit	Midpoint	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
at or below		10.60		0	.0000	0	.0000
1	10.60	11.30	10.95	1	.0159	1	.0159
2	11.30	12.00	11.65	0	.0000	1	.0159
3	12.00	12.70	12.35	0	.0000	1	.0159
4	12.70	13.40	13.05	0	.0000	1	.0159
5	13.40	14.10	13.75	0	.0000	1	.0159
6	14.10	14.80	14.45	2	.0317	3	.0476
7	14.80	15.50	15.15	3	.0476	6	.0952
8	15.50	16.20	15.85	9	.1429	15	.2381
9	16.20	16.90	16.55	11	.1746	26	.4127
10	16.90	17.60	17.25	4	.0635	30	.4762
11	17.60	18.30	17.95	7	.1111	37	.5873
12	18.30	19.00	18.65	8	.1270	45	.7143
13	19.00	19.70	19.35	8	.1270	53	.8413
14	19.70	20.40	20.05	0	.0000	53	.8413
15	20.40	21.10	20.75	4	.0635	57	.9048
16	21.10	21.80	21.45	3	.0476	60	.9524
17	21.80	22.50	22.15	1	.0159	61	.9683
18	22.50	23.20	22.85	2	.0317	63	1.0000
above	23.20			0	.0000	63	1.0000

Mean = 17.8905   Standard Deviation = 2.24569   Median = 17.7

TABLE A-36. Frequency Tabulation for JP-5 Olefins (Refer to Fig. 40)

Frequency Tabulation

Class	Lower Limit	Upper Limit	Midpoint	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
at or below		.000		0	.0000	0	.0000
1	.000	.200	.100	2	.0317	2	.0317
2	.200	.400	.300	6	.0952	8	.1270
3	.400	.600	.500	13	.2063	21	.3333
4	.600	.800	.700	12	.1905	33	.5238
5	.800	1.000	.900	11	.1746	44	.6984
6	1.000	1.200	1.100	8	.1270	52	.8254
7	1.200	1.400	1.300	4	.0635	56	.8889
8	1.400	1.600	1.500	1	.0159	57	.9048
9	1.600	1.800	1.700	1	.0159	58	.9206
10	1.800	2.000	1.900	1	.0159	59	.9365
11	2.000	2.200	2.100	2	.0317	61	.9683
12	2.200	2.400	2.300	1	.0159	62	.9841
13	2.400	2.600	2.500	1	.0159	63	1.0000
14	2.600	2.800	2.700	0	.0000	63	1.0000
above	2.800			0	.0000	63	1.0000

Mean = 0.920635   Standard Deviation = 0.509319   Median = 0.8

TABLE A-37. Frequency Tabulation for JP-5 Hydrogen Content
(Refer to Fig. 41)

Frequency Tabulation

Class	Lower Limit	Upper Limit	Midpoint	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
at or below		13.00		0	.0000	0	.0000
1	13.00	13.07	13.03	0	.0000	0	.0000
2	13.07	13.13	13.10	1	.0159	1	.0159
3	13.13	13.20	13.17	0	.0000	1	.0159
4	13.20	13.27	13.23	0	.0000	1	.0159
5	13.27	13.33	13.30	8	.1270	9	.1429
6	13.33	13.40	13.37	11	.1746	20	.3175
7	13.40	13.47	13.43	0	.0000	20	.3175
8	13.47	13.53	13.50	6	.0952	26	.4127
9	13.53	13.60	13.57	7	.1111	33	.5238
10	13.60	13.67	13.63	0	.0000	33	.5238
11	13.67	13.73	13.70	13	.2063	46	.7302
12	13.73	13.80	13.77	8	.1270	54	.8571
13	13.80	13.87	13.83	0	.0000	54	.8571
14	13.87	13.93	13.90	6	.0952	60	.9524
15	13.93	14.00	13.97	2	.0317	62	.9841
16	14.00	14.07	14.03	0	.0000	62	.9841
17	14.07	14.13	14.10	1	.0159	63	1.0000
18	14.13	14.20	14.17	0	.0000	63	1.0000
above	14.20			0	.0000	63	1.0000

Mean = 13.6048 Standard Deviation = 0.221016 Median = 13.6

APPENDIX B

Supplier-Reported Data for JP-8 and JP-5 Tenders

TABLE B-1. Supplier-Reported Properties of JP-8 Samples

Lab Code	Tank No.	Color, D 156	TAN, mg KOH/g D 3242	Arom., vol %, D 1319	Olefins, vol %, D 1319	Sulfur, mass %, D 4294	Distillation, D 86, C IBP	10 %	20 %	50 %	90 %	FBP	Flash Point,C D 93	Gravity, API, D 1298	Density, D 1298	Freeze Point,C D 2386	Kin Vis, -20 C,cSt, D 445	An-Grav Product D 1405	Smoke Point, D 1322	Copper Strip, D 130	JFTOT,D 3241 CP	Tube	Gum, mg/100 mL D 381	Filter, mg/L D 2276	Filter, Time,min D 2276	WISM D 3948	Cetane Index, D 976
SAMPLES FROM PORT JEROME, FRANCE																											
AL-16677-F	122	+30	0.012	16.8	1.6	0.06	142	168	176	192	224	237	41	46.3	0.7956	-51	3.9	6478	25.0	1A	0	0	1	0.3	7	98	43
AL-16770-F		+30	0.012	17.5	0.5	0.04	148	167	173	189	222	234	40	47.4	0.7907	-52	3.6	6624	25.6	1A	0	0	1	0.5	8	98	43
AL-16844-F	122	+30	0.012	17.8	1.0	0.06	145	166	173	189	222	236	40	47.1	0.7921	-52	3.5	6495	25.1	1A	0	0	1	0.1	8	95	43
AL-17034-F	122	+30	0.012	17.3	1.7	0.07	145	169	176	192	220	232	41	47.5	0.7902	-51	3.5	6623	25.7	1A	0	0	1	0.3	9	96	45
AL-17409-F		+30	0.012	16.4	0.7	0.05	145	171	177	193	223	237	41	49.8	0.7804	-50	3.6	6718	26.1	1A	0	0	1	0.3	11	98	45
AL-17638-F		+30	0.012	17.1	0.8	0.03	148	172	178	193	222	233	41	46.6	0.7942	-52	3.3	6497	25.0	1A	0	0	1	0.2	7	98	44
AL-17792-F		+30	0.001	19.9	0.7	0.02	150	174	180	195	223	244	40	47.5	0.7903	-51	3.4	6551	25.4	1A	0	0	1	1.0	11	98	44
MINIMUM		+30	0.001	16.4	0.5	0.02	142	166	173	189	220	232	40	46.3	0.7804	-52	3.3	6478	25.0		0	0	1	0.1	7	95	43
MAXIMUM		+30	0.012	19.9	1.7	0.07	150	174	180	195	224	244	41	49.8	0.7956	-50	3.9	6718	26.1		0	0	1	1.0	11	98	45
AVERAGE		+30	0.010	17.5	1.0	0.05	146	170	176	192	222	236	41	47.5	0.7905	-51	3.5	6569	25.4		0	0	1	0.4	9	97	44
SAMPLES FROM ST. THEODORI, GREECE																											
AL-15996-F	786	+20	0.005	12.6	0.1	0.20	147	166	174	195	236	259	41	45.8	0.7979	-48	4.1	6288	26.0	1A	0	1	2	0.7	12	90	43
AL-15996-F	772	+21	0.003	12.6	0.1	0.19	146	167	174	193	234	255	39	46.1	0.7964	-49	4.1	6630	26.0	1A	0	1	2	0.4	10	88	43
AL-15996-F	753	+18	0.003	12.5	0.1	0.12	150	168	176	196	236	254	42	45.9	0.7975	-48	4.0	6593	25.0	1A	0	1	2	0.5	11	90	44
AL-16025-F	787	+19	0.005	13.6	0.1	0.13	153	173	178	193	232	252	41	46.1	0.7963	-51	4.0	6480	26.0	1A	0	1	2	0.6	11	90	43
AL-16025-F	786	+19	0.008	15.0	0.1	0.10	153	174	176	192	234	259	41	46.3	0.7963	-48	4.4	6404	26.0	1A	0	1	1	0.4	7	90	43
AL-16025-F	772	+21	0.004	14.0	0.1	0.12	147	169	174	195	234	254	41	46.1	0.7966	-48	4.1	6777	26.0	1A	0	2	2	0.7	12	84	44
AL-16466-F	786	+11	0.004	18.9	1.1	0.22	146	170	178	201	240	254	41	45.9	0.7976	-48	3.5	6485	26.0	1A	0	1	2	0.5	8	91	[illegible]
AL-16466-F	787	-1	0.004	18.5	0.2	0.24	149	173	182	203	241	257	43	44.7	0.8028	-48	3.8	6338	26.0	1A	0	1	3	0.6	10	92	45
AL-16662-F	787	+12	0.002	16.5	0.2	0.15	148	172	179	199	235	251	44	46.0	0.7970	-49	3.9	6440	26.0	1A	0	1	2	0.7	7	87	47
AL-16662-F	786	+12	0.003	[illegible]	0.1	0.14	148	172	178	197	234	251	45	46.3	0.7954	-50	3.7	6648	26.0	1A	0	1	2	0.7	7	82	45
AL-16663-F	787	+8	0.003	16.0	0.1	0.17	152	175	181	202	240	258	47	45.6	0.7985	-49	3.7	6868	26.0	1A	0	1	2	0.9	8	90	46
AL-16663-F	786	+3	0.002	16.0	0.5	0.16	152	174	181	202	238	257	47	44.8	0.8023	-48	3.9	6474	26.0	1A	0	1	3	0.7	7	78	45
AL-16771-F	787	+12	0.004	14.5	0.1	0.18	152	168	176	194	231	246	45	46.6	0.7940	-49	3.9	6583	26.0	1A	0	1	2	0.8	6	90	43
AL-16771-F	786	+13	0.003	15.5	0.2	0.18	151	168	173	192	229	247	44	46.6	0.7942	-49	4.0	6630	25.0	1A	0	1	2	0.7	5	94	43
AL-17114-F	785	+16	0.006	13.5	0.6	0.10	151	172	178	189	220	244	48	47.4	0.7909	-57	3.3	6847	26.0	1A	0	1	2	0.6	6	85	43
AL-17114-F	786	+16	0.002	16.7	0.6	0.20	146	170	178	197	236	255	44	46.9	0.7926	-48	3.8	6785	25.0	1A	0	1	1	0.7	4	92	46
AL-17115-F	787	+17	0.002	13.2	0.2	0.19	146	170	179	199	237	256	42	[illegible]	[illegible]	-47	3.6	6783	26.0	1A	0	1	3	0.6	6	85	47
AL-17115-F	785	+16	0.006	13.5	0.6	0.10	151	172	178	189	220	244	48	47.4	0.7909	-57	3.3	6847	26.0	1A	0	1	0	0.6	6	85	43
AL-17228-F	785	+12	0.002	14.8	0.2	0.13	150	171	177	196	233	251	45	46.4	0.7947	-49	3.2	6630	26.0	1A	0	1	2	0.4	9	92	44
AL-17229-F	785	+14	0.005	16.5	0.6	0.11	148	170	177	197	231	251	44	45.3	0.7998	-50	3.2	6482	26.0	1A	0	1	3	0.5	5	94	43
AL-17425-F	786	+13	0.004	16.0	0.3	0.05	154	173	180	199	237	258	43	45.7	0.7980	-48	3.9	6578	26.0	1A	0	1	0	0.3	4	76	44
AL-17425-F	787	+16	0.00[illegible]	16.5	0.4	0.05	158	175	181	194	228	251	43	46.5	0.7947	-54	3.2	- - -	26.0	1A	0	1	2	0.4	6	78	44
AL-17426-F	786	+9	0.003	22.0	0.8	0.14	151	170	179	200	239	262	44	45.4	0.7998	-48	3.9	6383	23.0	1A	0	1	2	0.7	7	76	44
AL-17426-F	787	+14	0.004	16.5	0.8	0.12	147	166	175	194	229	252	42	45.6	0.7985	-50	3.9	6474	26.0	1A	0	1	2	0.7	8	86	43
AL-17533-F	785	+11	0.008	13.8	0.1	0.07	162	175	179	190	215	248	46	47.3	0.7912	-58	2.7	6785	27.0	1A	0	1	2	0.5	7	77	44

TABLE B-1. Supplier-Reported Properties of JP-8 Samples (Continued)

Lab Code	Tank No.	Color, D 156	TAN, mg KOH/g D 3242	Arom., vol %, D 1319	Olefins, vol %, D 1319	Sulfur, mass %, D 4294	Distillation, D 86, C IBP	10 %	20 %	50 %	90 %	FBP	Flash Point, C D 93	Gravity, API, D 1298	Density, D 1298	Freeze Point, C D 2386	Kin Vis, -20 C, cSt, D 445	An-Grav Product D 1405	Smoke Point, D 1322	Copper Strip, D 130	JFTOT, D 3241 CP	JFTOT, D 3241 Tube	Gum, mg/100 mL D 381	Filter, mg/L D 2276	Filter, Time, min D 2276	WSIM D 3948	Cetane Index, D 976
AL-17534-F	785	+17	0.005	14.5	0.6	0.07	152	173	179	193	225	247	45	46.5	0.7945	-55	2.8	6728	26.0	1A	0	1	2	0.5	6	84	44
AL-17593-F	785	+18	0.003	15.5	0.5	0.09	144	168	177	198	234	252	42	46.3	0.7956	-49	3.2	6673	26.0	1A	0	1	2	0.7	7	86	47
AL-17594-F	785	+22	0.006	15.1	0.3	0.06	147	169	178	199	236	256	43	46.5	0.7946	-47	3.1	6710	25.0	1A	0	1	2	0.3	5	84	46
AL-17736-F	785	+17	0.006	14.2	0.5	0.14	145	169	177	197	236	256	41	46.5	0.7944	-48	3.1	6753	26.0	1A	0	1	2	0.3	7	88	46
AL-17738-F	785	+17	0.004	14.0	0.5	0.15	149	171	179	200	236	256	43	46.0	0.7969	-49	3.4	7037	26.0	1A	0	1	3	0.6	10	86	46
AL-18105-F	785	+14	0.005	14.5	0.3	0.17	148	171	179	199	235	252	43	45.5	0.7989	-49	3.4	6418	27.0	1A	0	1	2	0.5	4	80	46
MINIMUM		-1	0.002	12.5	0.1	0.05	144	166	173	189	215	244	39	44.7	0.7909	-58	2.7	6288	23		0	1	0	0.3	4	76	43
MAXIMUM		+22	0.008	22.0	1.1	0.24	162	176	182	203	241	262	48	47.4	0.8028	-47	4.4	7037	27		0	2	3	0.9	12	94	47
AVERAGE		+14	0.004	15.3	0.4	0.14	150	171	178	196	233	253	43	46.2	0.7962	-50	3.6	6618	26		0	1	2	0.6	7	86	45
SAMPLES FROM HUELVA, SPAIN																											
AL-16418-F	130	- -	0.004	16.0	2.0	- -	162	182	- - -	207	- - -	264	52	46.2	0.7958	-47	4.6	6704	25.0	1A	1	0	0	0.4	7	96	49
AL-16418-F	137	- -	0.003	15.0	5.0	- -	172	191	- - -	211	- - -	259	58	44.6	0.8035	-48	5.0	6453	25.0	1A	1	0	0	0.3	9	96	48
AL-16676-F	137	- -	0.003	16.5	0.4	- -	166	189	- - -	217	250	272	55	41.2	0.8192	-50	6.4	5700	25.0	1A	1	1	0	0.6	10	96	44
AL-16676-F	138	- -	0.006	19.8	0.5	- -	161	180	- - -	211	253	275	54	41.3	0.8190	-49	5.3	5513	25.0	1A	1	2	1	0.4	10	96	42
AL-17617-F	137	- -	0.002	16.9	0.5	0.18	153	169	177	211	248	270	47	43.8	0.8068	-50	4.6	6116	21.0	1A	1	1	- - -	0.8	11	98	42
AL-17617-F	130	- -	0.003	18.6	0.6	0.15	156	175	188	211	253	274	45	40.6	0.8216	-50	5.2	5418	20.0	1A	1	1	- - -	0.3	10	98	41
AL-17618-F	130	- -	0.003	18.6	0.6	0.15	156	175	186	211	253	274	45	40.6	0.8216	-50	5.2	5418	20.0	1A	1	1	- - -	0.3	10	98	41
AL-17619-F	137	- -	0.002	16.9	0.5	0.18	153	169	177	211	248	270	47	43.8	0.8068	-50	4.6	6116	21.0	1A	1	1	- - -	0.8	11	98	42
AL-17828-F	130	- -	0.009	13.6	0.5	0.06	155	180	190	212	248	273	54	40.7	0.8213	-49	4.8	5602	23.0	1A	1	1	1	0.2	12	73	40
AL-17829-F	137	- -	0.005	18.3	0.4	0.28	156	182	190	213	252	270	49	40.6	0.8220	-52	5.4	5439	22.0	1A	1	1	1	0.2	9	74	41
MINIMUM			0.002	13.6	0.4	0.06	153	169	177	207	248	259	45	40.6	0.7958	-52	4.6	5418	20.0		1	0	0	0.2	7	73	40
MAXIMUM			0.009	19.8	5.0	0.28	172	191	190	217	253	275	58	46.2	0.8220	-47	6.4	6704	25.0		1	2	1	0.8	12	98	49
AVERAGE			0.004	17.0	1.1	0.17	159	179	185	212	251	270	51	42.3	0.8138	-50	5.1	5848	22.7		1	1	1	0.4	10	92	43
SAMPLES FROM NORCO, LOUISIANA																											
AL-16091-F	453	+27	0.005	17.8	0.8	0.03	152	178	186	207	244	259	48	41.8	0.8165	-56	5.1	5643	22.0	1A	1	1	2	0.3	9	94	41
AL-16091-F	454	+27	0.008	18.0	1.5	0.03	152	178	185	206	242	258	48	41.8	0.8165	-57	5.0	5643	21.0	1A	1	1	2	0.2	9	92	40
AL-16236-F	453	+20	0.002	17.0	1.0	0.02	158	184	192	212	246	259	49	41.9	0.8160	-55	5.6	5803	22.0	1A	1	1	1	0.2	15	98	43
AL-16236-F	454	+14	0.003	16.7	1.1	0.02	157	182	189	208	243	258	48	41.9	0.8160	-57	5.3	5824	21.0	1A	1	1	1	0.2	10	92	41
MINIMUM		+14	0.002	16.7	0.8	0.02	152	178	185	206	242	258	48	41.8	0.8160	-57	5.0	5643	21.0		1	1	1	0.2	9	92	40
MAXIMUM		+27	0.008	18.0	1.5	0.03	158	184	192	212	246	259	49	41.9	0.8165	-55	5.6	5824	22.0		1	1	2	0.3	15	98	43
AVERAGE		+22	0.005	17.4	1.1	0.03	155	181	188	208	244	259	48	41.9	0.8163	-56	5.3	5728	21.5		1	1	2	0.2	11	94	41
SAMPLE FROM SINGAPORE																											
AL-16234-F	118	+25	0.006	19.0	1.0	0.08	147	167	174	201	253	277	40	44.8	0.8024	-50	4.0	- - -	21.0	1A	0	1	.	0.3	9	97	44

TABLE B-1. Supplier-Reported Properties of JP-8 Samples (Continued)

Lab Code	Tank No.	Color, D 156	TAN, mg KOH/g D 3242	Arom., vol %, D 1319	Olefins, vol %, D 131	Sulfur, mass %, D 4294	Distillation, D 86, C IBP	10 %	20 %	50 %	90 %	FBP	Flash Point, C D 93	Gravity, API, D 1298	Density, D 1298	Freeze Point, C D 2386	Kin Vis, -20 C, cSt, D 445	An-Grav Product D 1405	Smoke Point, D 1322	Copper Strip, D 130	JFTOT, D 3241 CP	JFTOT, D 3241 Tube	Gum, mg/100 mL D 381	Filter, mg/L D 2276	Filter, Time, min D 2276	WSIM D 3948	Cetane Index, D 976
SAMPLES FROM CASTALLON, SPAIN																											
AL-17087-F	744	- -	0.002	14.7	1.7	0.16	156	175	182	204	245	263	47	42.8	0.8117	-49	4.6	- - -	20.0	1A	0	0	0	0.6	8	85	42
AL-17087-F	743	- -	0.002	12.4	1.5	0.15	159	180	187	210	247	261	53	41.4	0.8184	-49	4.6	- - -	20.0	1A	1	0	0	0.4	7	95	42
AL-17220-F	744	+30	0.003	9.1	1.1	0.13	151	170	179	206	250	263	44	42.2	0.8149	-50	4.7	- - -	20.0	1A	1	0	0	0.6	8	98	41
AL-176!6-F	744	- -	0.003	16.6	0.2	0.09	144	162	168	190	247	268	41	45.0	0.8013	-49	3.7	6138	22.0	1A	0	0	1	0.9	8	97	40
MINIMUM		+30	0.002	9.1	0.2	0.09	144	162	168	190	245	261	41	41.4	0.8013	-50	3.7	6138	20.0		0	0	0	0.4	7	85	40
MAXIMUM		+30	0.003	16.6	1.7	0.16	159	180	187	210	250	268	53	45.0	0.8184	-49	4.7	6138	22.0		1	0	1	0.9	8	98	42
AVERAGE		+30	0.003	13.2	1.1	0.13	153	172	179	203	247	264	46	42.9	0.8116	-49	4.4	6138	20.5		1	0	0	0.6	8	94	41
SAMPLES FROM WEST GERMANY																											
AL-17542-F	311	- -	0.010	16.5	0.6	0.02	152	173	181	197	220	240	46	46.1	0.7962	-55	3.9	6520	24.0	1	0	1	- - -	0.3	6	98	45
AL-17601-F	304	- -	0.007	15.4	0.7	0.09	155	168	178	195	225	244	47	46.9	0.7930	-53	3.9	6690	25.0	1	0	0	1	0.1	6	97	46
AL-17725-F	304	- -	0.001	15.0	0.6	0.06	152	171	178	194	222	238	47	46.4	0.7950	-54	3.9	6574	25.0	1	0	0	!	0.2	6	98	46
AL-17835-F	66	- -	0.010	17.2	1.0	0.01	149	162	167	179	220	249	41	44.7	0.8028	-60	3.4	5800	26.0	- - -	0	0	1	0.2	5	89	34
MINIMUM			0.001	15.0	0.6	0.01	149	162	167	179	220	238	41	44.7	0.7930	-60	3.4	5800	24.0		0	0	0	0.1	5	89	34
MAXIMUM			0.010	17.2	1.0	0.09	155	173	181	197	223	249	47	46.9	0.8028	-53	3.9	6690	26.0		0	1	1	0.3	6	98	46
AVERAGE			0.007	16.0	0.7	0.05	152	169	176	191	222	243	45	46.0	0.7968	-56	3.8	6396	25.0		0	0	1	0.2	6	96	43
SAMPLES FROM ROTTERDAM, NETHERLANDS																											
AL-16253-F	1099-P	+28	0.004	16.5	1.0	0.01	166	180	186	202	235	257	48	46.4	0.7952	-50	3.7	- - -	26.0	1	0	1	1	0.1	6	92	48
AL-16254-F	1101-P	+24	0.007	17.0	1.0	0.01	168	182	189	208	243	262	51	43.7	0.8074	-49	4.4	- - -	25.0	1	0	1	1	0.4	7	92	45
AL-16255-F	1099-P	+30	0.008	16.0	1.0	0.01	164	181	187	204	239	258	52	45.5	0.7990	-49	4.3	- - -	25.0	1	0	1	1	0.1	5	89	47
AL-16256-F	1101-P	+24	0.007	16.5	1.0	0.01	167	183	190	209	243	263	52	43.3	0.8090	-49	4.8	- - -	21.0	1	0	1	1	0.1	5	80	44
AL-16449-F	1099-P	+30	0.006	15.1	1.0	0.01	162	180	187	205	241	262	52	45.5	0.7992	-48	4.4	- - -	22.0	1	0	1	1	0.2	5	96	47
AL-16450-F	1078-P	+26	0.006	15.9	1.0	0.01	172	183	189	206	244	262	53	45.5	0.7993	-47	4.6	- - -	25.0	1	0	1	1	0.3	5	94	47
AL-16536-F	1099-P	+26	0.008	16.5	1.0	0.01	168	182	187	204	238	257	55	45.4	0.7998	-47	4.1	- - -	23.0	1	0	1	2	0.2	5	90	46
AL-16741-F	1099-P	+30	0.003	16.0	1.0	0.01	165	178	184	202	278	255	53	46.2	0.7960	-48	4.3	- - -	22.0	1	0	1	0	0.2	5	87	47
AL-16742-F	1100-P	+30	0.008	16.5	1.0	0.01	156	175	182	200	237	257	49	46.2	0.7962	-49	4.0	- - -	25.0	1	0	1	1	0.2	8	94	46
AL-16743-F	1102-P	+30	0.005	16.0	1.0	0.01	164	179	185	203	237	258	53	45.7	0.7985	-49	4.3	- - -	25.0	1	0	1	1	0.1	12	87	46
AL-17042-F	1078	+30	0.007	18.0	1.0	0.01	157	177	184	203	243	261	55	45.1	0.8012	-47	5.0	- - -	24.0	1	2	1	1	0.2	8	89	45
AL-17129-F	1078-P	+30	0.006	17.0	1.0	0.01	163	77	183	201	238	259	52	46.1	0.7966	-49	4.4	- - -	23.0	1	0	1	1	0.1	2	94	46
AL-17130-F	1099-P	+30	0.006	16.5	1.0	0.01	164	78	184	201	237	258	51	46.0	0.7968	-52	4.0	- - -	24.0	1	0	1	1	0.1	4	84	46
AL-17131-F	1100-P	+30	0.006	15.0	1.0	0.01	157	174	181	201	249	260	48	44.8	0.8024	-50	4.2	- - -	23.0	1	0	1	1	0.1	7	92	44
AL-17132-F	1101-P	+30	0.002	15.9	0.8	0.01	165	182	187	205	242	263	53	45.8	0.7978	-49	4.1	- - -	23.0	1	0	1	1	0.1	8	90	47
AL-17493-F	1100	+30	0.005	17.0	1.0	0.01	166	180	186	203	238	259	54	45.4	0.7996	-49	4.2	- - -	22.0	1	0	1	1	0.2	3	68	46
AL-17494-F	1101	+30	0.006	17.0	1.0	0.01	161	177	184	203	240	261	52	45.9	0.8017	-49	4.3	- - -	22.0	1	0	1	1	0.2	5	93	45

TABLE B-1. Supplier-Reported Properties of JP-8 Samples (Continued)

Lab Code	Tank No.	Color, D 156	TAN, mg KOH/g D 3242	Arom., vol %, D 1319	Olefins, vol %, D 1319	Sulfur, mass %, D 4294	Distillation, D 86, C IBP	10 %	20 %	50 %	90 %	FBP	Flash Point, C D 93	Gravity, API, D 1298	Density, D 1298	Freeze Point, C D 2386	Kin Vis, -20 C, cSt, D 445	An-Grav Product D 1405	Smoke Point, D 1322	Copper Strip, D 130	JFTOT, D 3241 CP	Tube	Gum, mg/100 mL D 381	Filter, mg/L D 2276	Filter, Time, min D 2276	WISM D 3948	Cetane Index, D 976
AL-17495-F	1102	+30	0.002	15.5	1.0	0.01	158	176	183	202	241	260	51	45.0	0.8015	-49	4.4	---	22.0	1	0	1	1	0.1	5	98	45
AL-17498-F	1100	+30	0.006	17.0	1.0	0.01	162	176	183	200	238	257	51	45.8	0.7979	-50	3.9	---	23.0	1	1	1	1	0.1	9	94	45
AL-17591-F	1099	+30	0.006	17.5	1.0	0.01	163	182	189	207	239	256	52	44.0	0.8059	-51	4.5	---	21.0	1	0	1	1	0.3	6	95	44
AL-17592-F	1099	+30	0.006	17.5	1.0	0.01	163	182	189	207	239	256	52	44.0	0.8059	-51	4.5	---	21.0	1	0	1	1	0.3	6	95	44
AL-17623-F	1101	+30	0.007	17.0	1.0	0.01	166	180	186	203	237	257	52	44.9	0.8018	-50	4.2	---	24.0	1	0	1	1	0.1	8	94	45
AL-17624-F	1100	+30	0.006	17.0	1.0	0.01	162	176	183	200	238	257	51	45.8	0.7979	-50	3.9	---	23.0	1	1	1	1	0.1	9	94	45
AL-17625-F	1099	+30	0.001	17.0	1.0	0.01	160	179	186	206	243	263	49	43.7	0.8072	-49	4.5	---	20.0	1	0	1	1	0.1	9	98	44
AL-18116-F	1101-P	+26	0.006	17.0	1.0	0.01	170	182	187	205	241	260	52	45.2	0.8005	-48	4.4	---	22.0	1	0	1	1	0.3	9	95	46
AL-18147-F	1101-P	+27	0.006	17.5	1.0	0.01	164	179	185	203	237	256	50	45.1	0.8011	-50	4.4	---	22.0	1	0	1	---	0.2	8	92	45
AL-18157-F	1102-P	+30	0.005	17.5	1.0	0.01	167	183	189	205	236	255	55	45.7	0.7981	-49	4.4	---	25.0	1	0	1	1	0.2	11	91	47
MINIMUM		+24	0.001	15	0.8	0.01	156	174	181	200	235	255	48	43.3	0.7952	-52	3.7		20		0	1	0	0.1	2	80	44
MAXIMUM		+30	0.008	18	1.0	0.01	172	183	190	209	278	263	55	46.4	0.8090	-47	5.0		26		2	1	2	0.4	12	98	48
AVERAGE		+29	0.006	17	1.0	0.01	164	179	186	204	241	259	52	45.2	0.8005	-49	4.3		23		0	1	1	0.2	7	91	46
SAMPLES FROM KILLINGHOLME, ENGLAND																											
AL-17907-F	819	+30	0.001	18.4	0.3	0.01	152	173	182	202	226	242	45	44.9	0.8019	-54	3.9	---	23.0	1B	0	1	1	0.2	5	99	45
AL-17908-F	818	+30	0.001	19.6	0.3	0.01	151	171	180	198	224	242	44	45.2	0.8008	-55	4.0	---	24.0	1B	0	1	1	0.2	5	91	43
MINIMUM		+30	0.001	18.4	0.3	0.01	151	171	180	198	224	242	44	44.9	0.8008	-55	3.9		23.0		0	1	1	0.2	5	91	43
MAXIMUM		+30	0.001	19.6	0.3	0.01	152	173	182	202	226	242	45	45.2	0.8019	-54	4.0		24.0		0	1	1	0.2	5	99	45
AVERAGE		+30	0.001	19.0	0.3	0.01	152	172	181	200	225	242	45	45.1	0.8014	-55	4.0		23.5		0	1	1	0.2	5	95	44
SAMPLES FROM PRIOLO, SICILY																											
AL-16965-F	1319	- -	0.005	14.9	0.1	0.11	153	171	176	192	223	243	45	46.6	0.7945	-55	3.3	---	28.0	1A	2	1	2	0.6	8	80	42
AL-16965-F	1309	- -	0.005	13.2	0.3	0.10	153	173	179	195	226	246	46	46.3	0.7955	-56	3.3	---	30.0	1A	2	1	0	0.6	7	78	48
AL-17186-F	1309	- -	0.005	14.0	0.2	0.05	149	165	169	186	221	242	42	48.8	0.7845	-56	3.3	---	30.0	1A	2	1	0	1.2	---	72	45
AL-17186-F	1321	- -	0.005	12.6	0.2	0.09	144	166	170	185	220	240	41	49.4	0.7822	-53	3.3	---	26.0	1A	2	1	0	1.6	---	72	45
AL-17231-F	1321	- -	0.005	12.4	0.3	0.08	151	165	168	186	224	246	41	48.5	0.7860	-50	3.3	---	27.0	1A	2	1	0	0.7	11	80	45
AL-17231-F	1309	- -	0.005	12.9	0.1	0.08	148	165	169	184	221	238	41	49.7	0.7807	-50	3.3	---	28.0	1A	2	1	0	0.1	7	70	47
AL-17260-F	1309	- -	0.005	13.5	0.2	0.08	149	168	174	190	226	248	42	48.9	0.7843	-50	3.3	---	27.0	1A	2	1	0	1.0	11	71	47
AL-17505-F	1321	- -	0.005	10.8	0.1	0.06	147	165	170	185	217	239	39	49.8	0.7802	-53	3.3	---	27.0	1A	2	1	---	1.6	18	78	46
AL-17505-F	1319	- -	0.005	11.5	0.3	0.08	144	165	170	185	219	290	39	49.2	0.7828	-50	3.3	---	27.0	1A	2	1	0	0.7	10	80	45
AL-17627-F	1319	- -	0.005	12.0	0.3	0.04	149	167	171	186	219	244	38	48.7	0.7849	-52	3.3	---	27.0	1A	2	1	---	0.2	7	70	44
AL-17627-F	1309	- -	0.005	10.4	0.2	0.05	150	167	171	185	217	241	39	49.7	0.7806	-49	3.3	---	29.0	1A	2	1	---	0.8	9	70	46
AL-17767-F	1319	- -	0.005	12.7	0.3	0.04	149	168	171	187	221	242	40	48.6	0.7855	-52	3.3	---	28.0	1A	2	1	---	0.5	8	74	45
AL-17767-F	1309	- -	0.005	11.7	0.2	0.06	144	165	171	185	217	239	41	49.3	0.7824	-50	3.3	---	29.0	1A	2	1	---	0.7	9	82	46
AL-18123-F	1319	- -	0.005	10.7	0.3	0.04	149	166	171	185	217	238	42	49.0	0.7836	-52	3.3	---	28.0	1A	2	1	---	0.9	14	86	45

TABLE B-1. Supplier-Reported Properties of JP-8 Samples (Continued)

Lab Code	Tank No.	Color, D 156	TAN, mg KOH/g D 3242	Arom., vol %, D 1319	Olefins, vol %, D 1319	Sulfur, mass %, D 4294	Distillation, D 86, C IBP	10 %	20 %	50 %	90 %	FBP	Flash Point, C D 93	Gravity, API, D 1298	Density, D 1298	Freeze Point, C D 2386	Kin Vis, -20 C, cSt, D 445	An-Grav Product D 1405	Smoke Point, D 1322	Copper Strip, D 130	JFTOT, D 3241 CP	Tube	Gum, mg/100 mL D 381	Filter, mg/L D 2276	Filter, Time, min D 2276	WISM D 3948	Cetane Index, D 976
AL-18123-F	1309	- -	0.005	11.0	0.3	0.03	141	166	171	187	223	242	41	48.4	0.7868	-51	3.3	- - -	28.0	1A	0	1	- - -	0.5	9	82	45
MINIMUM			0.005	10.4	0.1	0.03	141	165	168	184	217	238	38	46.3	0.7802	-56	3.3		26		0	1	0	0.1	0	70	42
MAXIMUM			0.005	14.9	0.3	0.11	153	173	179	195	226	290	46	49.8	0.7955	-49	3.3		30		2	1	2	1.6	18	88	48
AVERAGE			0.005	12.3	0.2	0.07	148	167	171	187	221	245	41	48.7	0.7850	-52	3.3		28		2	1	0	0.8	9	78	45

TABLE B-2. Supplier-Reported Properties of JP-5 Samples

Lab Code	Tank No.	Color, D 156	TAN, mg KOH/g D 3242	Arom., vol %, D 1319	Olefins, vol %, D 1319	Sulfur, mass %, D 4294	Distillation, D 86, C IBP	10 %	20 %	50 %	90 %	FBP	Flash Point, C D 93	Gravity, API D 1298	Density, D 1298	Freeze Point, C D 2386	Kin Vis, -20 C, cSt, D 445	An-Grav Product D 1405	Smoke Point D 1322	Copper Strip D 130	JFTOT, D 3241 CP	Tube	Gum, mg/100 mL D 381	Filter, mg/L D 2276	Filter Time, min D 2276	MSEP D 3948	Cetane Index, D 976
SAMPLES FROM DEER PARK, TX																											
AL-16775-F	6314	+21	0.003	19.4	0.7	0.01	185	196	201	214	241	256	68	41.2	0.8189	-52	- -	5644	20.0	1B	0	1	2	0.2	4	89	43
AL-16796-F	6319	+27	0.003	18.8	0.8	0.01	182	194	199	213	239	254	66	41.6	0.8171	-53	- -	5782	21.0	1B	0	1	1	0.2	5	95	43
AL-16824-F	6314	+21	0.002	18.9	2.0	0.04	187	198	201	214	238	252	69	41.8	0.8161	-54	- -	5810	20.0	1B	0	1	1	0.2	4	75	44
AL-16836-F	6319	+27	0.003	19.4	0.6	0.03	182	196	201	216	243	259	63	42.5	0.8128	-51	- -	5993	21.0	1B	0	1	2	0.1	3	95	46
AL-16841-F	6352	+27	0.004	19.2	0.4	0.05	[illegible]	193	198	212	238	253	63	42.6	0.8124	-53	- -	5916	21.0	1B	0	1	1	0.2	4	90	44
AL-16861-F	6319	+24	0.004	[illegible]	[illegible]	0.01	[illegible]	[illegible]	197	210	238	254	63	42.6	0.8124	-52	- -	5900	20.0	1B	0	1	1	0.3	4	89	44
AL-16963-F	6314	+25	0.006	19.3	0.6	0.03	189	199	204	217	242	258	69	41.8	0.8161	-51	- -	5957	20.0	1A	0	1	1	0.1	4	94	45
AL-16964-F	6347	+26	0.005	19.2	0.6	0.04	179	191	196	210	238	255	63	42.5	0.8128	-53	- -	5865	20.0	1B	0	1	1	0.2	5	92	43
AL-17072-F	6345	+26	0.002	20.0	0.6	0.06	179	190	196	211	241	257	62	42.3	0.8138	-52	- -	5837	20.0	1B	0	1	2	0.6	4	91	43
AL-17073-F	6314	+24	0.002	19.2	0.6	0.01	187	197	202	214	239	254	68	41.9	0.8156	-58	- -	5908	20.0	1B	2	1	1	0.1	4	95	44
AL-17110-F	6347	+24	0.002	18.1	0.5	0.09	181	196	200	212	241	258	64	43.8	0.8068	-48	- -	6285	20.0	1B	1	1	1	0.1	4	95	47
AL-17124-F	6314	+21	0.003	18.9	1.1	0.07	181	191	196	211	241	277	67	42.6	0.8124	-51	- -	5985	20.0	1B	1	1	1	0.3	4	91	44
AL-17188-F	6319	+21	0.002	20.3	0.6	0.03	182	193	198	213	241	271	63	42.4	0.8133	-50	- -	5915	20.0	1B	1	1	1	0.1	4	92	44
AL-17234-F	6347	+24	0.003	20.6	0.6	- - -	188	198	202	216	245	267	66	42.2	0.8142	-48	- -	5844	20.0	1B	2	1	1	0.1	6	94	45
AL-17270-F	6319	+25	0.003	19.5	0.6	0.17	181	192	196	209	237	260	64	41.9	0.8156	-55	- -	5740	19.0	1B	1	1	1	0.1	4	84	42
AL-17305-F	6319	+25	0.003	20.5	0.9	0.01	183	193	198	211	253	258	67	42.2	0.8142	-50	- -	5832	19.0	1B	1	1	2	0.1	4	93	43
AL-17352-F	6314	+26	0.004	20.3	0.6	0.36	183	194	198	212	240	258	67	41.8	0.8161	-51	- -	5768	19.0	1B	1	1	1	0.1	4	92	42
AL-17373-F	6314	+27	0.002	20.9	1.0	0.06	186	194	198	206	242	256	67	41.4	0.8180	-54	- -	5782	19.0	1B	0	1	1	0.2	4	97	41
AL-17395-F	314	+18	0.004	16.6	0.5	0.06	170	192	197	212	242	266	61	42.2	0.8142	-44	5.4	5992	21.5	1A	0	1	0	0.7	2	61	43
AL-17416-F	6347	+22	0.003	20.5	1.6	0.02	187	198	202	216	242	259	67	41.3	0.8185	-51	- -	5699	- - -	1B	0	1	1	0.0	8	76	43
AL-17524-F	6314	+26	0.005	20.9	0.9	0.02	189	198	202	214	239	252	68	41.4	0.8180	-51	- -	5817	- - -	1B	1	1	1	0.1	4	91	43
AL-17525-F	6314	+27	0.006	19.5	0.9	0.02	186	195	200	213	239	258	66	42.1	0.8147	-49	- -	5999	19.0	1B	1	1	1	0.1	3	89	44
AL-17543-F	6319	+24	0.004	20.5	0.9	0.23	187	196	201	213	243	267	68	41.6	0.8171	-48	- -	5803	20.0	1B	1	1	1	0.1	4	77	43
AL-17587-F	6314	+24	0.003	19.8	0.9	0.01	187	196	200	213	241	261	67	41.9	0.8156	-50	- -	5988	20.0	1B	1	1	0	0.1	4	84	43
AL-17602-F	6347	+26	0.004	20.2	0.3	0.01	187	197	201	213	241	256	69	41.1	0.8194	-51	- -	5713	19.0	1B	0	1	2	0.2	3	71	42
AL-17701-F	6319	+24	0.001	19.3	0.5	0.01	184	194	199	212	239	257	67	42.2	0.8142	-49	- -	5887	21.0	- -	0	1	1	0.2	3	85	44
AL-17764-F	6345	+20	0.002	19.1	0.8	0.02	182	193	199	214	241	259	64	42.1	0.8147	-51	- -	5915	20.0	1B	0	1	1	0.3	3	85	43
AL-17805-F	6314	+20	0.004	20.4	0.8	0.01	188	202	207	217	243	261	70	40.3	0.8232	-64	- -	5507	20.0	1B	0	1	1	0.1	4	91	42
AL-17806-F	6352	+21	0.004	19.0	1.0	0.02	190	200	204	217	237	267	69	41.7	0.8166	-51	- -	6026	22.0	1B	0	1	1	0.1	4	92	44
AL-17815-F	6347	+19	0.006	19.4	0.8	0.02	187	197	202	214	239	261	63	42.1	0.8147	-52	- -	5843	20.0	1B	0	1	1	0.2	3	90	43
AL-17906-F	DIPOPL	+17	0.003	19.4	0.4	0.01	187	198	202	214	242	267	68	42.6	0.8124	-51	- -	5985	20.0	1B	0	1	2	0.1	3	84	44
AL-18106-F	6352	+17	0.003	19.0	1.0	0.01	190	200	204	216	242	266	70	42.1	0.8147	-51	5.9	5930	19.0	1B	0	1	1	0.1	3	82	44
AL-18125-F	DIPOPL	+27	0.004	19.0	0.5	0.01	186	190	194	214	238	261	67	42.5	0.8128	-51	- -	6120	20.0	1B	0	1	1	0.2	2	88	49
AL-18167-F	DIPOPL	+27	0.004	19.0	1.0	0.04	187	194	201	214	244	262	68	41.9	0.8156	-52	- -	6055	19.0	1B	0		2	0.1	3	81	44
MINIMUM		+17	0.001	16.6	0.3	0.01	170	190	194	206	237	252	61	40.3	0.8068	-64	5.4	5507	19.0		0	1	0	0.0	2	71	41
MAXIMUM		+27	0.006	20.9	2	0.23	190	202	207	217	253	277	70	43.8	0.8232	-44	5.9	6285	22.0		2	1	2	0.7	8	97	49
AVERAGE		+24	0.003	19.5	0.8	0.04	184	193	200	213	241	260	66	42.0	0.8151	-52	5.7	5884	19.9		0	1	1	0.2	4	89	44

TABLE B-2. Supplier-Reported Properties of JP-5 Samples (Continued)

Lab Code	Tank No.	Color, D 156	TAN, mg KOH/g D 3242	Arom., vol %, D 1319	Olefins, vol %, D 1319	Sulfur, mass %, D 4294	Distillation, D 86, C IBP	10 %	20 %	50 %	90 %	FBP	Flash Point, C D 93	Gravity, API D 1298	Density, D 1298	Freeze Point, C D 2386	Kin Vis, -20 C, cSt, D 445	An-Grav Product D 1405	Smoke Point D 1322	Copper Strip D 130	JFTOT, D 3241 CP	JFTOT, D 3241 Tube	Gum, mg/100 mL D 381	Filter, mg/L D 2276	Filter Time, min D 2276	MISM D 3948	Cetane Index, D 976
													SAMPLES FROM ABILENE, TX														
AL-16792-F	65	+20	0.002	15.9	1.1	0.03	174	186	191	204	232	257	61	43.5	0.8082	-43	- -	6329	21.5	1A	0	1	2	0.2	7	86	43
AL-16833-F	65	+19	0.002	17.5	1.1	0.02	177	189	195	210	240	257	61	43.5	0.8082	-44	- -	6351	21.0	1A	0	1	1	0.3	9	91	45
AL-16918-F	65	+20	0.002	16.0	1.8	0.01	180	194	198	212	241	257	62	43.5	0.8082	-44	- -	6351	22.0	1A	0	1	1	0.1	6	81	46
AL-16958-F	65	+18	0.001	16.6	1.6	0.01	173	187	192	207	238	252	61	43.5	0.8082	-44	- -	6351	22.0	1A	0	1	1	0.4	7	85	44
AL-17059-F	65	+18	0.001	16.4	1.3	0.01	176	187	192	210	244	270	60	43.5	0.8082	-44	- -	6351	21.5	1A	0	1	1	0.4	9	79	45
AL-17098-F	65	+17	0.001	16.9	1.7	0.04	177	189	194	210	240	264	61	43.3	0.8091	-44	- -	6365	22.0	1A	0	1	3	0.2	7	82	45
AL-17136-F	65	+17	0.001	16.8	2.0	0.02	177	188	193	209	239	261	60	43.6	0.8077	-44	- -	6322	22.0	1A	0	1	1	0.3	8	94	45
AL-17222-F	65	+18	0.001	16.7	1.4	0.02	177	188	193	210	243	260	62	43.5	0.8082	-44	- -	6329	22.0	1A	0	0	2	0.5	7	80	45
AL-17225-F	65	+17	0.001	17.1	1.5	0.02	179	193	197	212	242	264	62	43.7	0.8073	-44	- -	6358	21.0	1A	0	0	3	0.4	10	81	46
AL-17275-F	65	+17	0.002	18.4	1.7	0.03	181	192	197	212	242	264	62	43.6	0.8077	-44	- -	6344	22.0	1A	0	1	2	0.3	8	84	46
AL-17350-F	65	+17	0.001	17.1	1.6	0.02	186	191	195	211	242	269	62	43.5	0.8082	-44	- -	6308	23.0	1A	0	1	2	0.2	8	78	45
AL-17365-F	65	+17	0.001	16.8	1.6	0.02	178	191	196	211	241	264	60	43.8	0.8068	-44	- -	6373	22.0	1A	0	1	1	0.4	9	79	46
AL-17532-F	65	-16	0.002	16.1	1.3	0.02	179	190	194	209	239	261	61	43.7	0.8073	-44	- -	6315	22.0	1A	0	0	2	0.1	7	86	45
AL-17563-F	65	+17	0.002	16.1	1.5	0.02	174	188	192	207	229	250	61	43.7	0.8073	-43	- -	6358	23.0	1A	0	1	1	0.5	8	83	44
AL-17565-F	65	+17	0.002	16.0	1.4	0.02	178	191	195	209	238	256	61	43.6	0.8077	-44	- -	6322	21.5	1A	0	1	1	0.5	12	89	44
AL-17600-F	65	+17	0.001	15.8	2.2	0.02	178	192	196	210	239	257	63	43.7	0.8073	-43	- -	6380	22.0	1A	0	1	2	0.4	8	83	46
AL-17700-F	65	+18	0.002	19.6	1.6	0.04	174	186	191	206	237	250	61	43.7	0.8073	-44	- -	6358	21.5	1A	0	1	2	0.2	9	83	44
AL-17734-F	65	+18	0.002	15.8	1.3	0.02	177	191	196	210	239	259	62	43.5	0.8082	-44	- -	6308	22.0	1A	0	1	1	0.8	6	86	45
AL-17785-F	65	+18	0.001	16.5	1.8	0.03	178	191	195	210	241	258	60	43.8	0.8068	-43	- -	6351	21.0	1A	0	1	3	0.2	8	86	46
AL-17814-F	65	+17	0.002	15.7	1.5	0.02	179	191	196	211	242	262	61	43.7	0.8073	-44	- -	6380	22.0	1A	0	0	2	0.3	8	80	46
AL-18124-F	65	+18	0.004	16.1	1.8	0.03	177	187	191	207	239	253	61	43.7	0.8073	-44	- -	6337	21.5	1A	0	1	2	0.4	7	87	44
AL-18140-F	65	+16	0.002	14.7	1.4	0.02	181	192	196	211	241	267	62	43.6	0.8077	-44	5.3	6344	22.0	1A	0	1	4	0.3	8	87	46
AL-18155-F	65	-17	0.001	15.9	1.6	0.03	176	183	191	206	238	252	62	43.7	0.8073	-44	- -	6337	22.0	1A	0	0	2	0.3	8	82	44
MINIMUM		-17	0.001	14.7	1.1	0.01	173	183	191	204	229	250	60	43.3	0.8068	-44	5.3	6308	21.0		0	0	1	0.1	8	78	43
MAXIMUM		+20	0.004	19.6	2.2	0.04	186	194	198	212	244	270	63	43.8	0.8091	-43	5.3	6380	23.0		0	1	4	0.8	12	91	46
AVERAGE		+15	0.002	16.5	1.6	0.02	178	189	194	209	239	259	61	43.6	0.8077	-44	5.3	6344	21.8		0	1	2	0.3	7	84	45
													SAMPLES FROM BAKERSFIELD, CA														
AL-16794-F	10003	-2	0.002	20.5	1.0	0.11	177	186	189	199	222	250	61	40.5	0.8223	-56	4.8	5225	20.2	1A	0	1	1	0.3	3	97	35
AL-16795-F	10003	-7	0.001	19.3	1.1	0.11	176	188	191	202	224	249	60	40.4	0.8228	-60	5.2	5414	19.5	1A	0	1	3	0.2	4	91	36
AL-17642-F	3022	-8	0.001	19.0	1.1	0.12	185	200	204	214	236	259	68	39.6	0.8266	-55	5.4	- - -	19.0	1A	0	1	0	0.6	0	88	40
AL-17643-F	10004	-7	0.001	19.2	0.7	0.13	189	200	203	213	233	269	71	39.4	0.8276	-55	6.0	5319	19.5	1A	0	1	0	0.2	0	79	39
AL-17644-F	3022	-7	0.001	19.3	1.6	0.13	184	202	206	215	235	259	67	39.4	0.8276	-55	6.5	5398	20.0	1B	0	1	0	0.2	0	85	40
AL-17645-F	10004	-7	0.001	19.3	0.8	0.13	184	200	204	214	233	256	69	39.5	0.8271	-54	6.5	5017	19.5	1A	0	1	0	0.4	5	86	39
AL-17646-F	10003	-7	0.001	19.5	0.9	0.12	188	202	207	215	232	258	43	39.2	0.8285	-50	6.6	5331	19.0	1A	0	1	1	0.5	6	85	39
AL-17647-F	10004	-7	0.001	19.2	1.4	0.12	188	203	206	214	231	254	71	39.3	0.8280	-55	6.0	5384	20.0	1A	0	1	0	0.6	5	85	39
AL-17854-F	10004	-7	0.001	19.8	1.4	0.13	183	198	203	212	223	252	68	39.3	0.8280	-55	5.0	5266	20.0	1A	0	1	0	0.4	4	86	38
AL-17855-F	10003	-6	0.001	20.4	0.3	0.12	190	203	205	214	233	253	69	39.4	0.8276	-53	6.4	5358	19.0	1A	0	1	0	0.3	6	84	39
AL-18158-F	10003	-16	0.004	20.4	1.3	0.13	180	196	200	209	226	246	66	39.5	0.8271	-55	6.0	5254	19.5	1A	0	1	1	0.3	4	90	37
AL-18159-F	3022	-7	0.002	19.2	0.7	0.12	178	197	202	212	231	261	65	39.8	0.8256	-60	6.0	5293	19.0	1A	0	1	2	0.5	5	71	39

TABLE B-2. Supplier-Reported Properties of JP-5 Samples (Continued)

Lab Code	Tank No.	Color, D 156	TAN, mg KOH/g D 3242	Arom., vol %, D 1319	Olefins, vol %, D 1319	Sulfur, mass %, D 4294	Distillation, D 86, C IBP	10 %	20 %	50 %	90 %	FBP	Flash Point, C D 93	Gravity, API D 1298	Density, D 1298	Freeze Point, C D 2386	Kin Vis, -20 C, cSt, D 445	An-Grav Product D 1405	Smoke Point D 1322	Copper Strip D 130	JFTOT, D 3241 CP	Tube	Gum, mg/100 mL D 381	Filter, mg/L D 2276	Filter Time, min D 2276	WISM D 3948	Cetane Index, D 976
MINIMUM		-16	0.001	19.2	0.3	0.11	176	186	189	199	222	246	43	39.2	0.8223	-60	4.8	5017	19.0		0	1	0	0.2	0	71	35
MAXIMUM		-2	0.004	20.5	1.6	0.13	190	203	207	215	236	269	71	40.5	0.8285	-50	6.6	5414	20.2		0	1	3	0.6	6	97	40
AVERAGE		-7	0.001	19.7	1.0	0.12	184	198	202	211	230	256	65	39.6	0.8266	-55	5.9	5296	19.5		0	1	1	0.4	4	86	38
SAMPLE FROM BEAUMONT, TX																											
AL-16825-F	710	+30	0.003	20.5	0.5	0.12	179	190	195	209	235	253	62	42.2	0.8142	-52	5.3	5760	21.0	1A	1	0	1	0.2	6	98	42
SAMPLES FROM CORPUS CHRISTI, TX																											
AL-16826-F	89	+30	0.007	23.1	0.3	0.02	180	194	199	209	236	267	67	43.7	0.8073	-48	5.1	6074	23.0	1A	0	1	1	0.6	3	95	45
AL-16854-F	89	+30	0.008	19.3	0.2	0.02	177	191	195	206	233	261	66	45.2	0.8004	-49	4.9	6486	21.0	1A	0	1	0	0.7	6	94	47
AL-16866-F	89	+30	0.008	19.0	0.5	0.02	177	189	193	204	- -	258	64	45.4	0.7995	-49	5.1	6469	23.0	1A	0	1	1	0.5	3	94	46
AL-17047-F	89	+30	0.008	[illegible]	0.3	0.00	180	191	194	205	233	256	63	45.7	0.7982	-49	4.8	6580	23.0	1A	0	1	1	1.0	4	92	47
AL-17088-F	89	+30	0.007	[illegible]	0.3	0.01	180	190	193	204	231	262	66	45.8	0.7777	-50	4.9	5641	23.0	1A	0	1	0	0.7	7	98	47
AL-17116-F	89	+30	0.002	20.1	0.4	0.01	184	192	196	205	235	262	66	43.8	0.8068	-50	4.9	6154	21.0	1A	0	1	1	0.9	5	91	44
AL-17187-F	89	+30	0.004	19.4	0.5	0.01	176	188	192	203	232	260	62	44.0	0.8059	-51	4.9	6116	23.0	1A	0	1	1	0.5	4	96	43
AL-17213-F	89	+30	0.006	16.3	0.9	0.01	180	191	196	210	233	263	67	43.9	0.8064	-48	4.9	6167	23.0	1A	0	1	0	0.3	4	100	46
AL-17226-F	89	+30	0.004	17.4	0.0	0.01	180	190	194	206	235	258	64	44.8	0.8022	-49	4.9	6339	23.0	1A	0	1	0	0.5	4	98	46
AL-17257-F	89	+30	0.006	16.0	0.4	0.02	178	186	189	201	229	254	62	45.1	0.8009	-51	5.1	6382	23.0	1A	0	1	1	0.3	4	99	45
AL-17304-F	89	+30	0.008	15.5	1.0	0.01	186	190	196	207	234	260	66	45.6	0.7986	-48	4.9	6512	23.0	1A	0	1	1	0.5	5	99	48
AL-17422-F	89	+30	0.004	17.5	0.7	0.01	179	187	190	202	226	251	62	46.0	0.7968	-50	4.9	6624	24.0	1A	0	1	1	0.5	5	98	47
AL-17562-F	89	+16	0.002	13.6	1.7	0.04	184	192	- -	208	233	258	67	45.9	0.7973	-46	4.9	6724	24.0	1A	0	1	1	0.6	5	89	49
AL-17728-F	89	+30	0.010	16.0	0.8	0.01	188	196	200	207	228	257	70	45.4	0.7995	-47	5.1	6673	24.0	1A	0	1	1	0.6	4	98	48
MINIMUM		+16	0.002	13.6	0.0	0.00	176	186	189	201	226	251	62	43.7	0.7968	-51	4.8	5641	21.0		0	1	0	0.3	3	89	43
MAXIMUM		+30	0.010	23.1	1.7	0.04	188	196	200	210	236	267	70	46.0	0.8073	-46	5.1	6724	24.0		0	1	1	1.0	7	100	49
AVERAGE		+29	0.006	17.8	0.6	0.01	181	191	194	206	232	259	65	45.0	0.8012	-49	5.0	6353	22.9		0	1	1	0.6	5	96	46
SAMPLES FROM HANFORD, CA																											
AL-16828-F	5014	- -	0.001	21.3	0.8	0.12	184	190	193	202	221	246	64	39.9	0.8252	-60	- -	5111	19.4	1A	0	1	4	0.3	4	86	35
AL-16829-F	10013	- -	0.003	22.4	0.8	0.12	188	195	197	206	225	243	67	39.6	0.8266	-54	- -	5112	19.4	1A	0	1	5	0.3	4	90	36
MINIMUM			0.001	21.3	0.8	0.12	184	190	193	202	221	243	64	39.6	0.8252	-60		5111	19.4		0	1	4	0.3	4	86	35
MAXIMUM			0.003	22.4	0.8	0.12	188	195	197	206	225	246	67	39.9	0.8266	-54		5112	19.4		0	1	5	0.3	4	90	36
AVERAGE			0.002	21.9	0.8	0.12	186	193	195	204	223	244.5	66	39.8	0.8259	-57		5112	19.4		0	1	5	0.3	4	88	36
SAMPLES FROM NEWHALL, CA																											
AL-16830-F	5001	-16	0.002	15.8	0.8	0.25	176	188	194	209	236	259	62	38.7	0.8310	-50	5.9	5184	19.5	1A	0	1	3	0.2	5	78	36
AL-16831-F	5002	-16	0.003	14.8	0.9	0.26	176	190	196	211	240	263	63	38.3	0.8329	-52	6.3	5132	19.5	1A	0	1	2	0.3	7	80	36
AL-16834-F	5001	-16	0.003	16.6	0.8	0.27	174	190	197	212	238	262	67	38.2	0.8334	-51	6.6	5118	19.5	1A	0	1	4	0.6	5	76	36

TABLE B-2. Supplier-Reported Properties of JP-5 Samples (Continued)

Lab Code	Tank No.	Color, D 156	TAN, mg KOH/g D 3242	Arom., vol %, D 1319	Olefins, vol %, D 1319	Sulfur, mass %, D 4294	Distillation, D 86, C IBP	10 %	20 %	50 %	90 %	FBP	Flash Point, C D 93	Gravity, API D 1298	Density, D 1298	Freeze Point, C D 2386	Kin Vis, -20 C, cSt, D 445	An-Grav Product D 1405	Smoke Point D 1322	Copper Strip D 130	JFTOT, D 3241 CP	Tube	Gum, mg/100 mL D 381	Filter, mg/L D 2276	Filter Time, min D 2276	WSIM D 3948	Cetane Index, D 976
AL-16833-F	5002	-16	0.002	15.7	0.7	0.27	174	192	196	214	239	264	62	38.2	0.8334	-48	6.4	5118	19.5	1A	0	1	3	0.4	7	77	36
AL-16842-F	5001	-16	0.002	16.7	0.9	0.25	170	190	196	211	236	258	68	38.3	0.8329	-50	6.6	5132	19.0	1A	0	1	3	0.2	4	76	35
AL-16856-F	5002	-16	0.002	16.2	1.1	0.25	168	190	200	215	241	265	62	37.9	0.8349	-50	6.8	5116	19.5	1A	0	1	5	0.3	4	78	37
AL-16857-F	5001	-16	0.002	17.7	1.0	0.23	170	188	195	213	238	264	62	38.4	0.8319	-49	6.3	5184	19.5	1A	0	1	4	0.4	4	75	38
AL-16858-F	5001	-16	0.002	17.7	1.0	0.23	170	188	195	213	238	264	62	38.4	0.8319	-49	6.3	5184	19.5	1A	0	1	4	0.4	4	75	38
AL-16859-F	5001	-16	0.002	15.3	0.9	0.24	175	194	197	214	241	262	62	38.3	0.8329	-49	6.3	5170	19.5	1A	0	1	3	0.2	4	77	38
AL-16862-F	5002	-16	0.002	14.4	0.7	0.24	172	192	196	214	238	264	66	38.1	0.8339	-47	6.5	5105	19.5	1A	0	1	5	0.3	4	78	37
AL-16865-F	5001	-16	0.006	18.7	0.5	0.24	168	187	196	212	240	268	64	38.2	0.8334	-48	6.4	5157	19.5	1A	0	1	2	0.5	4	74	37
AL-16961-F	5002	-16	0.003	16.8	0.8	0.24	172	188	196	210	236	261	62	38.3	0.8329	-48	6.3	5132	19.0	1A	0	1	3	0.4	4	76	36
AL-16969-F	5001	-16	0.004	17.3	0.8	0.25	173	192	197	209	236	269	64	38.3	0.8329	-48	6.2	5132	19.0	1A	0	1	2	0.5	4	80	36
AL-16970-F	5002	-16	0.003	16.8	1.0	0.24	174	191	197	210	235	257	65	38.4	0.8324	-49	6.3	5145	19.5	1A	0	1	4	0.6	4	76	36
AL-17044-F	5001	-16	0.002	16.5	0.6	0.23	168	190	196	210	234	270	64	38.7	0.8310	-50	6.0	5185	19.9	1A	0	1	2	0.2	4	78	37
AL-17068-F	5002	-16	0.002	18.1	1.2	0.27	171	193	197	210	240	264	64	38.2	0.8334	-48	6.5	5159	19.9	1A	0	1	2	0.8	4	79	37
AL-17069-F	5001	-16	0.003	15.4	0.9	0.24	167	186	193	210	238	256	60	39.0	0.8295	-51	5.7	5226	20.6	1A	0	1	2	0.6	4	79	37
AL-17070-F	5001	-16	0.002	15.2	2.5	0.24	172	184	190	204	235	258	60	39.0	0.8295	-50	5.8	5226	19.4	1A	0	1	2	0.3	4	72	35
AL-17071-F	5002	-16	0.001	16.0	1.0	0.25	169	190	198	209	238	258	62	38.7	0.8310	-50	6.0	5185	19.9	1A	0	1	3	0.4	4	78	40
AL-17099-F	5001	-16	0.002	16.3	1.9	0.25	173	186	192	208	237	261	64	38.6	0.8315	-50	6.0	5172	19.4	1A	0	1	3	0.4	4	77	36
AL-17100-F	5001	-16	0.002	15.7	1.0	0.23	170	183	187	202	232	250	62	39.0	0.8295	-51	5.7	5226	19.4	1A	0	1	3	0.3	5	75	34
AL-17101-F	5002	-16	0.002	17.0	1.4	0.24	170	184	192	208	236	257	61	38.0	0.8305	-56	6.0	5199	19.4	1A	0	1	3	0.7	4	75	36
AL-17108-F	5002	-16	0.007	15.8	1.6	0.25	174	187	194	209	236	257	63	38.7	0.8310	-50	6.0	5158	19.9	1A	0	1	4	0.2	4	74	36
AL-17117-F	5001	-16	0.002	16.3	1.9	0.25	173	186	192	208	237	261	64	38.6	0.8315	-50	6.0	5172	19.4	1A	0	1	3	0.4	4	77	36
AL-17117-F	5002	-16	0.002	16.1	2.8	0.30	174	188	194	210	237	260	65	38.5	0.8319	-49	6.2	5159	19.9	1A	0	1	3	0.6	5	79	36
AL-17125-F	5001	-16	0.002	16.7	2.1	0.27	172	188	192	209	237	262	62	38.2	0.8334	-50	6.2	5118	19.9	1A	0	1	4	0.2	4	76	35
AL-17135-F	5002	-16	0.002	18.3	1.6	0.27	174	188	194	208	237	262	65	38.2	0.8334	-51	6.2	5146	19.9	1A	0	1	2	0.3	4	73	36
AL-17208-F	5001	-16	0.002	15.7	1.1	0.26	172	188	194	209	237	258	65	38.3	0.8329	-51	6.1	5118	19.4	1A	0	1	3	0.2	4	79	36
AL-17209-F	5002	-16	0.002	15.0	2.1	0.23	174	186	194	208	236	254	62	38.6	0.8315	-51	5.7	4786	19.5	1A	0	1	4	0.9	4	87	35
AL-17216-F	5001	-16	0.004	15.6	1.2	0.25	173	185	192	206	236	252	63	38.4	0.8324	-54	6.0	4877	19.7	1A	0	1	2	0.4	4	78	34
AL-17217-F	5002	-16	0.002	18.5	2.0	0.28	168	185	191	210	244	270	63	38.2	0.8334	-48	6.5	4851	19.9	1A	0	1	2	0.1	4	82	35
AL-17223-F	5001	-16	0.002	14.7	2.2	0.26	170	187	192	209	238	261	60	38.4	0.8324	-53	6.0	4876	19.9	1A	0	2	3	0.4	4	77	36
AL-17356-F	5001	-16	0.002	21.8	2.7	0.29	169	186	193	212	243	266	62	37.9	0.8349	-50	6.4	5041	19.2	1A	2	1	2	1.0	4	74	36
AL-17374-F	5001	-16	0.011	19.4	1.2	0.27	172	192	197	211	237	264	63	38.3	0.8329	-51	6.2	5132	19.7	1A	0	1	1	0.5	4	80	36
AL-17375-F	5001	-15	0.010	19.6	1.8	0.26	179	195	200	212	236	264	67	38.1	0.8339	-51	6.2	5105	19.6	1A	1	1	2	0.6	4	80	36
AL-17410-F	5001	-16	0.001	20.8	1.7	0.25	168	187	193	208	235	260	64	38.4	0.8324	-52	5.8	5146	19.4	1A	1	1	1	0.0	4	87	35
AL-17411-F	5002	-16	0.013	17.8	0.8	0.26	178	190	197	210	236	256	66	38.3	0.8329	-50	6.0	5132	19.6	1A	0	1	2	0.3	4	78	36
AL-17424-F	5001	-16	0.002	17.8	0.3	0.27	176	189	196	211	240	262	62	38.2	0.8334	-50	6.3	5119	19.3	1A	0	1	1	0.7	4	83	36
AL-17496-F	5001	-16	0.002	16.6	0.1	0.21	174	190	195	212	244	267	65	38.1	0.8339	-49	6.2	5105	19.7	1A	1	1	1	0.7	3	86	36
AL-17519-F	5002	-16	0.002	19.6	1.1	0.26	166	194	200	213	241	264	64	38.0	0.8348	-50	6.1	5092	19.3	1A	0	1	1	0.6	4	82	36
AL-17522-F	5001	-16	0.002	17.3	0.7	0.25	173	188	194	212	244	272	63	37.8	0.8354	-48	6.4	5065	19.7	1A	0	1	1	0.5	4	81	35
AL-17523-F	5002	-16	0.002	17.0	0.7	0.23	173	190	196	211	244	272	63	39.3	0.8280	-51	6.1	5264	19.7	1A	1	1	1	0.4	2	81	37
AL-17531-F	5001	-16	0.002	18.7	0.6	0.26	174	191	196	210	242	268	63	38.2	0.8334	-50	6.1	5119	- - -	1A	0	1	3	0.4	3	81	36
AL-17552-F	5002	-16	0.002	18.7	0.8	0.28	171	189	195	210	242	265	63	38.0	0.8344	-46	6.1	5146	19.4	1A	1	1	1	0.7	4	86	35
AL-17561-F	5001	-16	0.002	16.6	0.3	0.28	177	192	197	210	235	260	67	38.0	0.8344	-47	6.3	4978	19.2	1A	0	1	2	6.2	3	81	35
AL-17588-F	5002	-16	0.002	19.1	0.7	0.31	171	189	196	212	246	268	63	37.8	0.8354	-46	6.3	4952	19.4	1A	0	1	2	0.6	0	79	35
AL-17605-F	5001	-16	0.001	14.5	0.6	0.30	174	190	196	210	238	261	65	38.2	0.8334	-46	6.2	5004	19.9	1A	0	1	2	0.4	0	77	35

TABLE B-2. Supplier-Reported Properties of JP-5 Samples (Continued)

Lab Code	Tank No.	Color, D 156	TAN, mg KOH/g D 3242	Arom., vol %, D 1319	Olefins, vol %, D 1319	Sulfur, mass %, D 4294	Distillation, D 86, C IBP	10 %	20 %	50 %	90 %	FBP	Flash Point, C D 93	Gravity, API D 1298	Density, D 1298	Freeze Point, C D 2386	Kin Vis, -20 C, cSt, D 445	An-Grav Product D 1405	Smoke Point D 1322	Copper Strip D 130	JFTOT, D 3241 CP	JFTOT, D 3241 Tube	Gum, mg/100 mL D 381	Filter, mg/L D 2276	Filter Time, min D 2276	WISM D 3948	Cetane Index, D 976
AL-17626-F	5002	-16	0.002	15.9	0.6	0.30	176	194	199	212	238	258	66	38.2	0.8334	-47	6.1	5004	19.6	1A	0	1	3	0.4	0	84	36
AL-17695-F	5001	-16	0.002	17.3	0.8	0.32	177	194	200	214	238	260	67	37.8	0.8354	-50	6.4	4952	19.2	1A	2	1	3	0.6	5	82	35
AL-17726-F	5002	-16	0.003	18.3	0.9	0.28	177	194	199	212	248	261	66	38.0	0.8344	-45	6.2	4978	19.9	1A	0	1	4	0.3	0	79	36
AL-17733-F	5001	-16	0.002	16.5	0.6	0.32	177	191	197	211	236	263	65	38.2	0.8334	-46	6.1	5004	19.2	1A	0	1	2	0.3	4	84	36
AL-17747-F	5002	-26	0.003	15.8	0.6	0.31	173	191	197	211	240	263	65	38.1	0.8339	-46	6.1	4991	19.2	1A	0	1	5	0.4	4	84	35
AL-17765-F	5001	-16	0.003	16.2	0.6	0.36	170	186	192	208	241	269	62	38.5	0.8319	-46	5.6	5043	19.6	1A	0	1	2	0.7		88	35
AL-17794-F	5002	-16	0.003	17.3	0.4	0.34	174	188	194	208	238	261	62	39.3	0.8280	-46	5.9	5266	19.3	1A	0	1	3	0.4	4	84	36
AL-17795-F	5001	-16	0.003	16.9	0.3	0.34	174	187	193	208	240	273	64	38.4	0.8324	-46	5.7	5146	19.9	1A	0	1	2	0.3	3	90	35
AL-17816-F	5002	-16	0.003	16.4	0.5	0.30	173	187	193	207	237	269	64	38.6	0.8314	-51	5.6	5172	19.9	1A	0	1	2	0.7	5	85	35
AL-17831-F	5001	-16	0.002	13.9	0.2	0.32	173	186	191	207	237	264	62	38.5	0.8319	-51	5.8	5144	19.6	1A	0	1	3	0.3	5	87	35
AL-17832-F	5001	-16	0.003	14.5	0.4	0.31	174	187	192	208	242	275	64	38.4	0.8324	-46	5.7	5146	19.6	1A	0	1	2	0.2	5	92	37
AL-17833-F	5002	-16	0.003	14.7	0.3	0.30	172	187	193	207	240	269	62	38.6	0.8314	-46	5.5	5172	19.9	1A	0	1	2	0.4	5	90	35
AL-17836-F	5002	-16	0.003	15.3	0.6	0.29	177	189	194	209	242	266	63	38.4	0.8324	-46	5.8	5146	19.9	1A	0	1	1	0.5	5	93	35
AL-18122-F	5001	-16	0.005	17.[illegible]	0.5	0.30	174	187	194	210	240	264	64	38.5	0.8319	-46	6.0	5159	19.9	1A	0	1	2	0.5	4	71	36
AL-18153-F	5001	-16	0.004	17.8	0.2	0.25	176	192	200	216	244	268	66	38.0	0.8344	-47	6.5	5092	19.9	1A	0	1	2	0.2	5	80	38
AL-18154-F	5002	-16	0.005	17.0	0.2	0.25	176	194	201	214	241	265	65	38.2	0.8334	-44	6.5	5119	19.9	1A	0	1	3	0.9	5	80	37
AL-18169-F	5001	-16	0.003	18.0	0.3	0.25	176	193	199	213	239	269	62	38.1	0.8339	-44	6.5	5105	19.9	1A	0	1	2	0.9	6	80	36
MINIMUM		-25	0.001	13.9	0.1	0.21	166	183	187	202	232	250	60	37.8	0.8280	-56	5.5	4786	19.0		0	1	1	0	0	71	34
MAXIMUM		-16	0.013	21.8	2.8	0.36	179	195	201	216	246	275	68	39.3	0.8354	-44	6.8	5266	20.6		2	2	5	1	7	93	40
AVERAGE		-16	0.003	16.9	1.0	0.27	173	189	195	210	239	263	64	38.4	0.8327	-49	6.1	5108	19.6		0	1	3	0	4	88	36
SAMPLES FROM BATON ROUGE, LA																											
AL-16845-F	403/87	+30	0.006	18.2	1.4	0.05	184	202	206	218	242	253	70	41.0	0.8199	-51	6.0	5761	22.0	1A	0	1	1	0.2	7	99	44
AL-16845-F	402/93	+27	0.011	16.9	0.8	0.05	186	199	205	218	243	256	67	41.4	0.8180	-51	6.5	5837	22.0	1A	0	1	0	0.2	7	97	44
AL-16917-F	402	+22	0.002	19.2	0.9	0.04	188	199	205	218	244	257	67	41.0	0.8190	-50	6.0	5802	20.0	1A	0	1	0	0.5	7	98	44
AL-16919-F	403	+27	0.006	19.3	0.7	0.06	179	204	209	221	243	258	71	40.4	0.8228	-49	6.3	5636	22.0	1A	2	1	1	0.2	7	---	44
AL-16962-F	410	+30	0.003	17.5	1.0	0.03	182	201	206	219	243	257	67	41.0	0.8199	-51	6.1	5802	20.0	1A	2	1	0	0.2	6	---	44
AL-17035-F	403	+30	0.005	16.7	1.3	0.05	189	204	208	221	243	258	69	40.8	0.8208	-52	6.2	5712	22.0	1A	2	1	3	0.5	8	89	44
AL-17057-F	403	+30	0.005	16.7	1.3	0.05	185	204	208	221	243	258	69	40.8	0.8208	-52	6.2	5712	22.0	1A	2	1	3	0.5	8	99	44
AL-17058-F	402	+27	0.005	16.9	1.2	0.05	185	202	207	219	243	257	67	41.1	0.8194	-50	6.1	5836	21.0	1A	1	1	1	0.4	8	89	44
AL-17062-F	403	+27	0.003	15.6	0.4	0.04	183	202	207	221	245	259	68	41.2	0.8189	-50	6.3	5974	21.0	1A	2	1	0	0.2	7	75	45
AL-17063-F	410	+24	0.003	16.2	0.3	0.04	179	201	206	219	242	257	68	41.1	0.8194	-51	6.2	5898	22.0	1A	0	1	0	0.1	6	87	44
AL-17083-F	404	+30	0.006	16.3	1.1	0.05	186	199	203	218	243	257	67	41.6	0.8171	-51	6.0	5907	22.0	1A	0	1	0	0.1	6	74	45
AL-17084-F	402	+30	0.003	15.6	0.7	0.04	182	201	206	219	245	258	68	41.4	0.8180	-51	6.2	6044	21.0	1A	2	1	1	0.3	7	83	45
AL-17357-F	0402	+30	0.005	16.7	0.6	0.04	182	202	209	222	246	258	68	41.0	0.8161	-48	6.4	6103	23.0	1A	4	1	0	0.2	7	84	47
AL-17358-F	402	+28	0.014	15.4	1.4	0.04	178	202	207	221	245	259	68	41.6	0.8171	-50	6.3	5970	21.0	1A	9	1	0	0.3	12	87	46
AL-17359-F	404	+30	0.006	15.6	1.0	0.04	180	203	208	221	243	257	67	41.3	0.8185	-50	6.2	5968	22.0	1A	2	0	2	0.6	7	95	45
AL-17640-F	402	+30	0.005	15.9	1.0	0.02	187	201	206	219	244	257	69	41.5	0.8175	-49	6.1	6018	21.0	1A	2	2	1	0.7	0	88	45
AL-17730-F	403	+21	0.007	15.7	0.5	0.03	179	201	206	219	245	258	64	41.5	0.8175	-50	6.1	6059	22.0	1A	0	1	1	0.2	10	92	45
AL-17786-F	402	+27	0.007	15.7	0.3	0.03	183	200	206	220	246	260	68	41.6	0.8171	-48	6.1	6053	22.0	1A	0	1	--	0.3	6	94	45
AL-17787-F	402	+28	0.004	15.6	1.2	0.04	179	202	208	222	249	263	68	41.1	0.8194	-50	6.4	6001	22.0	--	0	2	1	0.1	8	96	45
AL-17853-F	410	+23	0.005	16.2	0.4	0.04	187	199	204	217	247	260	66	41.0	0.8199	-51	6.3	5925	22.0	1A	1	1	1	0.3	7	88	43

TABLE B-2. Supplier-Reported Properties of JP-5 Samples (Continued)

Lab Code	Tank No.	Color, D 156	TAN, mg KOH/g D 3242	Arom., vol %, D 1319	Olefins, vol %, D 1319	Sulfur, mass %, D 4294	Distillation, D 86, C IBP	10 %	20 %	50 %	90 %	FBP	Flash Point, C D 93	Gravity, API D 1298	Density, D 1298	Freeze Point, C D 2386	Kin Vis, -20 C, cSt, D 445	An-Grav Product D 1405	Smoke Point D 1322	Copper Strip D 130	JFTOT, D 3241 CP	Tube	Gum, mg/100 mL D 381	Filter, mg/L D 2276	Filter Time, min D 2276	MISM D 3948	Cetane Index, D 976
AL-17905-F	403	+27	0.003	15.1	0.9	0.04	180	203	208	220	246	262	69	41.1	0.8194	-50	6.3	6001	21.0	1A	0	1	0	0.4	10	85	45
AL-18117-F	402	+26	0.007	14.8	1.2	0.04	188	201	236	218	242	256	68	41.5	0.8175	-50	6.1	6018	23.0	1A	2	1	1	0.4	4	90	44
AL-18126-F	410	+30	0.005	16.0	0.7	0.03	184	196	202	216	241	255	66	41.2	0.8194	-49	6.1	5953	23.0	1A	0	1	0	0.2	7	98	43
AL-18170-F	402	+26	0.007	15.8	0.8	0.03	185	203	208	221	245	259	68	41.1	0.8194	-49	6.2	5918	23.0	1A	0	1	1	0.5	8	91	45
AL-18171-F	410	+30	0.004	16.0	0.7	0.03	187	200	206	219	246	261	66	41.1	0.8194	-50	6.3	5960	22.0	1A	0	1	1	0.2	10	89	44
AL-18172-F	403	+27	0.001	16.2	2.0	0.03	187	201	206	219	247	260	67	41.1	0.8194	-51	6.2	5939	24.0	1A	0	1	1	0.2	8	85	44
MINIMUM		+21	0.001	14.8	0.3	0.02	178	196	202	216	241	253	64	40.4	0.8161	-52	6.0	5636	20.0		0	0	0	0.1	0	74	43
MAXIMUM		+30	0.014	19.3	2.0	0.06	189	204	209	222	249	268	71	41.8	0.8228	-48	8.5	6103	24.0		9	2	3	0.7	12	99	47
AVERAGE		+28	0.005	16.4	0.9	0.04	184	201	206	219	244	258	68	41.2	0.8189	-50	6.3	5916	21.8		1	1	1	0.3	7	89	45
SAMPLE FROM EWA BEACH, HI																											
AL-16836-F	503	+28	0.004	22.9	1.1	0.06	174	192	199	214	240	252	63	40.4	0.8228	-47	5.8	5370	19.0	1A	2	1	0	0.7	6	81	41
SAMPLES FROM SICILY																											
AL-16863-F	507	+30	0.006	18.8	0.3	0.03	173	184	189	200	219	238	61	45.2	0.8004	-60	4.6	6373	22.0	1B	2	1	1	0.6	8	86	44
AL-17235-F	8041	+30	0.001	10.8	0.2	- - -	181	190	193	202	224	241	68	45.7	0.7981	-60	4.6	6777	25.0	1A	3	0	0	0.7	5	82	46
AL-17271-F	517	+30	0.007	19.0	0.5	0.03	176	188	192	203	222	236	63	43.8	0.8068	-60	4.6	6058	21.0	1B	2	1	1	0.6	8	74	43
AL-17351-F	8041	+30	0.001	11.0	0.5	0.01	183	192	196	205	226	243	71	45.6	0.7986	-60	4.8	7012	29.0	1A	3	0	1	0.5	5	82	47
AL-17414-F	517	+30	0.007	18.8	0.5	0.02	177	188	192	202	223	246	62	43.9	0.8064	-60	- -	6103	21.0	1B	2	1	1	0.6	0	90	43
AL-17521-F	516	+30	0.006	18.0	0.3	0.03	175	184	191	200	218	233	62	44.3	0.8046	-60	4.5	6955	21.0	1B	1	1	1	0.6	8	80	43
AL-17527-F	517	+30	0.007	18.8	0.5	0.02	177	188	192	202	233	246	62	43.9	0.8064	-60	4.6	6103	21.0	1B	2	1	1	0.6	8	90	43
AL-17535-F	8041	+30	0.001	10.9	0.3	0.01	180	188	191	195	230	250	64	45.2	0.8003	-60	4.8	6913	26.0	1A	2	0	1	0.3	0	84	46
AL-17620-F	517	+30	0.008	19.9	0.5	0.03	178	189	193	204	225	245	62	43.9	0.8064	-60	4.6	6132	21.0	1B	2	1	2	0.8	0	76	43
AL-17628-F	8041	+30	0.001	10.8	0.4	0.01	177	187	190	204	231	248	64	45.4	0.7995	-60	5.3	7026	27.0	1B	3	0	1	0.2	4	84	46
AL-17796-F	517	+30	0.008	18.8	0.4	0.03	175	191	196	206	227	244	62	43.5	0.8080	-60	4.6	6003	22.0	1A	2	1	1	0.8		85	44
AL-18142-F	517	+30	0.007	18.8	0.3	0.07	174	188	191	202	221	237	61	43.3	0.8091	-60	4.6	5932	22.0	1B	2	1	1	0.7	8	92	45
MINIMUM		+30	0.001	10.8	0.2	0.01	173	184	189	195	218	233	61	43.3	0.7981	-60	4.5	5932	21.0		1	0	0	0.2	0	74	43
MAXIMUM		+30	0.008	19.8	0.5	0.07	183	192	196	206	233	250	71	45.7	0.8091	-60	5.3	7026	29.0		3	1	2	0.8	8	92	47
AVERAGE		+30	0.005	16.2	0.4	0.03	177	188	192	202	225	242	64	44.5	0.8037	-60	4.7	6374	23.2		2	1	1	0.6	5	84	44
SAMPLES FROM FERNDALE, WA																											
AL-16864-F	11	+28	0.006	18.5	0.5	0.07	- -	- -	- -	- -	- -	- -	61	41.3	0.8185	-47	3.7	5452	21.0	1B	0	0	1	0.4	8	84	41
AL-17060-F	11	+30	0.006	21.4	0.5	0.03	- -	- -	- -	- -	- -	- -	63	41.1	0.8194	-48	4.6	5672	21.0	1B	0	0	1	0.4	6	93	41
AL-17061-F	11	+23	0.001	21.8	0.6	0.02	- -	- -	- -	- -	- -	- -	63	40.9	0.8204	-46	4.6	5624	19.0	1B	0	0	1	0.2	8	86	40
AL-17093-F	11	+21	0.006	21.7	0.5	0.04	- -	- -	- -	- -	- -	- -	68	41.2	0.8189	-48	4.4	5871	19.0	1B	0	0	1	0.1	12	82	39
AL-17095-F	15	+21	0.007	22.1	0.5	0.07	- -	- -	- -	- -	- -	- -	63	41.0	0.8199	-50	4.5	5576	19.0	1B	0	0	1	1.0	7	86	44
AL-17111-F	11	+27	0.006	22.4	0.6	0.04	176	193	196	210	256	287	64	41.1	0.8194	-47	4.7	5672	21.0	1B	0	0	1	0.1	8	84	41
AL-17121-F	11	+14	0.006	22.4	0.5	0.04	- -	- -	- -	- -	- -	- -	61	41.1	0.8194	-48	5.2	5569	21.5	1B	0	0	1	0.5	9	81	40
AL-17272-F	11	+28	0.005	21.6	0.5	0.04	- -	192	- -	212	258	287	62	41.1	0.8180	-49	5.0	5672	20.0	1B	0	0	1	0.2	3	92	41

TABLE B-2. Supplier-Reported Properties of JP-5 Samples (Continued)

Lab Code	Tank No.	Color, D 156	TAN, mg KOH/g D 3242	Arom., vol %, D 1319	Olefins, vol %, D 1319	Sulfur, mass %, D 4294	Distillation, D 86, C IBP	10 %	20 %	50 %	90 %	FBP	Flash Point, C D 93	Gravity, API D 1298	Density, D 1298	Freeze Point, C D 2386	Kin Vis, -20 C, cSt, D 445	An-Grav Product D 1405	Smoke Point D 1322	Copper Strip D 130	JFTOT, D 3241 CP	Tube	Gum, mg/100 mL D 381	Filter, mg/L D 2276	Filter Time, min D 2276	WSIM D 3948	Cetane Index, D 976
AL-17341-F	11	+28	0.002	23.2	0.5	0.05	175	189	194	210	250	276	62	40.5	0.8223	-49	4.4	5609	19.0	1B	0	0	1	0.2	3	79	40
AL-17352-F	11	+22	0.007	24.2	0.8	0.03	179	192	195	211	256	286	61	41.0	0.8199	-48	4.6	5556	19.0	1B	0	0	1	0.1	6	82	41
AL-17515-F	11	+27	0.007	22.5	0.8	0.02	178	188	192	206	253	286	60	41.4	0.8180	-50	4.8	5630	20.0	1B	0	0	1	0.1	5	73	40
AL-17526-F	11	+23	0.012	23.8	0.7	0.03	176	185	189	203	249	278	61	41.7	0.8166	-50	4.7	5775	21.0	1B	0	0	1	0.7	8	84	39
AL-17539-F	11	+28	0.008	22.5	0.5	0.02	176	187	191	206	248	278	62	41.7	0.8166	-49	4.3	5713	19.5	1B	0	0	1	0.4	3	90	40
AL-17564-F	11	+30	0.003	24.1	0.5	0.02	172	187	191	206	249	282	62	41.4	0.8180	-48	4.1	5679	21.0	1B	0	0	1	0.6	4	91	39
AL-17595-F	11	+21	0.007	24.0	0.8	0.06	- -	- -	- -	- -	- -	- -	63	40.7	0.8213	-51	5.2	5576	20.0	1B	0	0	1	0.4	3	86	40
AL-17622-F	11	+28	0.010	25.0	0.5	0.03	169	187	191	204	249	282	61	41.1	0.8194	-51	4.1	5631	21.0	1B	0	0	1	0.3	3	82	38
AL-17722-F	11	+27	0.003	23.8	0.8	0.02	168	185	188	202	248	283	62	41.7	0.8166	-51	3.9	5713	19.5	1B	0	0	1	0.2	10	89	39
AL-17740-F	11	+17	0.007	23.8	1.4	0.03	171	187	191	204	249	284	61	41.4	0.8180	-51	4.1	5630	21.0	1B	0	0	1	0.2	6	72	38
AL-17784-F	11	+28	0.013	23.7	0.4	0.05	177	188	192	206	247	279	63	41.1	0.8194	-51	4.4	5631	20.0	1B	0	0	1	0.9	12	84	39
AL-17810-F	11	+21	0.002	22.9	1.3	0.03	178	187	192	206	252	284	61	41.5	0.8175	-50	4.2	5686	21.0	1B	0	0	1	0.3	9	90	40
AL-17827-F	11	+27	0.001	24.6	1.3	0.04	184	191	196	208	251	277	66	41.1	0.8194	-60	4.0	5898	20.0	1B	0	0	1	0.3	5	79	40
AL-17837-F	11	+28	0.008	24.8	1.0	0.03	182	197	200	213	253	280	68	41.3	0.8185	-50	4.2	5658	20.0	1B	0	0	1	0.2	3	73	42
AL-17904-F	11	+21	0.010	23.5	0.6	0.03	179	193	197	212	256	281	63	41.4	0.8180	-49	3.9	5651	20.5	1B	0	0	1	0.6	4	81	42
AL-18156-F	11	+27	0.001	23.4	0.8	0.03	179	192	196	211	256	281	62	41.5	0.8175	-50	3.9	5727	20.0	1B	0	0	1	0.1	3	84	42
AL-18166-F	11	+29	0.007	23.7	0.6	0.02	179	192	196	211	258	281	64	41.8	0.8161	-48	3.9	5768	20.0	1A	0	0	1	0.5	3	86	42
MINIMUM		+14	0.001	18.5	0.4	0.02	168	185	188	202	247	277	60	40.5	0.8161	-60	3.7	5452	19.0		0	0	1	0.1	3	72	38
MAXIMUM		+30	0.013	25.0	1.4	0.07	184	197	209	213	258	287	68	41.8	0.8223	-46	5.2	5898	21.5		0	0	1	1.0	12	93	44
AVERAGE		+25	0.006	23.0	0.7	0.04	176	190	193	208	252	282	63	41.2	0.8187	-50	4.4	5666	20.2		0	0	1	0.4	6	84	40
SAMPLES FROM THREE RIVERS, TX																											
AL-17043-F	314	+27	0.002	17.9	0.5	0.04	176	191	195	209	238	273	62	42.9	0.8110	-44	4.8	5985	22.0	1A	0	1	2	0.8	2	75	44
AL-17109-F	314	+22	0.006	16.6	0.3	0.04	176	193	197	211	239	251	61	42.9	0.8110	-45	5.1	5984	21.0	1A	0	1	0	0.4	1	70	44
AL-17567-F	311	+28	0.005	18.9	0.3	0.04	178	192	196	211	244	279	62	42.6	0.8124	-47	4.8	6035	21.0	1A	0	1	1	0.9	8	86	44
AL-17641-F	311	+29	0.002	16.4	0.9	0.02	181	193	198	211	237	275	62	43.0	0.8105	-45	5.4	6149	22.0	1A	0	1	1	0.5	0	87	44
AL-17706-F	314	+30	0.004	18.1	0.7	0.02	178	192	196	209	241	278	62	43.4	0.8087	-45	4.1	6156	21.5	1A	0	1	1	0.6	5	100	45
AL-17727-F	311	+30	0.003	14.4	0.6	0.02	177	194	198	211	238	268	63	43.3	0.8091	-48	4.8	6156	21.5	1A	0	1	1	0.8	6	91	45
AL-17739-F	314	+27	0.003	18.9	0.5	0.02	182	193	196	207	236	261	64	43.4	0.8087	-45	- -	6077	21.0	1A	0	1	1	0.4	0	73	44
AL-17756-F	311	+26	0.002	15.9	0.4	0.03	180	191	195	207	237	264	60	43.2	0.8096	-43	4.5	6070	21.0	1A	0	1	1	0.7		86	44
MINIMUM		+22	0.002	14.4	0.3	0.02	176	191	195	207	236	261	60	42.6	0.8087	-48	4.1	5984	21.0		0	1	0	0.4	0	70	44
MAXIMUM		+30	0.006	18.9	0.9	0.04	182	194	198	211	244	279	64	43.4	0.8124	-43	5.4	6156	22.0		0	1	2	0.9	8	100	45
AVERAGE		+27	0.003	17.1	0.5	0.03	179	192	196	210	239	270	62	43.1	0.8101	-45	4.8	6077	21.4		0	1	1	0.6	3	84	44
SAMPLE FROM PASADENA, TX																											
AL-17082-F	6319	+25	0.002	18.8	0.4	0.04	185	195	199	213	239	257	64	42.5	0.8128	-57	- -	5814	20.0	1A	1	1	1	0.2	4	88	45
SAMPLES FROM TACOMA, WA																											
AL-17336-F	30002	+13	0.008	23.2	0.8	0.12	187	191	197	215	248	269	60	40.1	0.8242	-47	- -	5293	19.0	1A	0	1	2	0.1	4	59	41

TABLE B-2. Supplier-Reported Properties of JP-5 Samples (Continued)

Lab Code	Tank No.	Color, D 156	TAN, mg KOH/g D 3242	Arom., vol %, D 1319	Olefins, vol %, D 1319	Sulfur, mass %, D 4294	Distillation, D 86, C IBP	10 %	20 %	50 %	90 %	FBP	Flash Point, C D 93	Gravity, API D 1298	Density, D 1298	Freeze Point, C D 2386	Kin Vis, -20 C, cSt, D 445	An-Grav Product D 1405	Smoke Point D 1322	Copper Strip D 130	JFTOT, D 3241 CP	Tube	Gum, mg/100 mL D 381	Filter, mg/L D 2276	Filter Time, min D 2276	WSIM D 3948	Cetane Index, D 976
AL-17337-F	30002	+21	0.009	20.6	2.6	0.10	176	190	194	211	249	278	61	40.1	0.8242	-49	- -	5293	19.0	1A	0	1	0	0.6	5	75	39
AL-17338-F	30002	+25	0.008	22.6	1.0	0.12	175	189	196	214	251	281	60	40.2	0.8237	-49	- -	5400	19.0	1A	0	1	0	0.3	6	82	40
AL-17339-F	30002	+19	0.008	21.8	0.6	0.08	180	194	195	212	245	262	61	40.6	0.8218	-50	- -	5440	19.0	1A	0	1	2	0.5	4	76	41
AL-17[illegible]0-F	30002	+18	0.007	21.5	0.8	0.10	179	190	191	206	248	274	62	40.1	0.8242	-49	- -	5253	19.0	1A	0	1	1	0.9	6	75	37
AL-17766-F	30002	+12	0.012	21.0	1.2	0.12	169	189	195	213	249	270	60	40.5	0.8223	-48	- -	5285	20.0	1A	0	1	- -	0.2	6	89	41
MINIMUM		+12	0.007	20.6	0.6	0.08	169	189	191	206	245	262	60	40.1	0.8218	-50		5253	19.0		0	1	0	0.1	4	59	37
MAXIMUM		+26	0.012	23.2	2.6	0.12	187	194	197	215	251	281	62	40.6	0.8242	-47		5440	20.0		0	1	2	0.9	6	89	41
AVERAGE		+18	0.009	21.8	1.2	0.11	178	191	195	212	248	272	61	40.3	0.8234	-49		5327	19.2		0	1	1	0.4	5	76	40
SAMPLES FROM TORRANCE, CA																											
AL-17501-F	550-96	+14	0.004	11.3	2.1	0.01	187	197	201	209	224	238	64	36.7	0.8408	-63	6.3	4789	19.0	1A	0	1	2	0.5	3	96	33
AL-17603-F	800-13	+11	0.006	11.0	1.2	0.01	194	202	205	212	227	239	68	36.3	0.8420	-63	6.5	4841	19.0	1A	0	1	3	0.6	0	52	33
AL-17740-F	800-13	+2	0.014	14.4	1.1	0.01	191	202	207	218	239	256	70	36.1	0.8438	-63	- -	4837	19.0	- -	0	1	7	0.3	3	91	35
AL-18119-F	800X13	-4	0.005	13.9	0.5	0.01	189	200	204	215	236	251	71	36.2	0.8433	-60	7.1	4887	19.5	1A	0	1	4	0.4	3	83	34
MINIMUM		-4	0.004	11.0	0.5	0.01	187	197	201	209	224	238	64	36.1	0.8408	-68	6.3	4789	19.0		0	1	2	0.3	0	52	33
MAXIMUM		+14	0.014	14.4	2.1	0.01	194	202	207	218	239	256	71	36.7	0.8438	-63	7.1	4887	19.5		0	1	7	0.6	3	96	35
AVERAGE		+6	0.007	12.6	1.2	0.01	19.	200	204	214	232	246	68	36.3	0.8427	-64	6.6	4839	19.1		0	1	5	0.5	2	81	34

APPENDIX C

Cetane Values for JP-8 and JP-5 Fuels

TABLE C-1. Cetane Values for JP-8 Fuels

Lab Code	Location	Cetane No., D 613	Cetane Index, D 976	Cetane Index, D 4737
AL-15996-F	St Theodori,Greece	44.9	44.8	46.9
AL-16025-F	St Theodori,Greece	46.2	44.7	46.8
AL-16084-F	Huelva,Spain	43.5	43.0	44.2
AL-16091-F	Norco,Louisiana	40.4	41.0	42.1
AL-16234-F	Singapore	43.1	44.2	46.2
AL-16236-F	Norco,Louisiana	41.9	41.9	42.9
AL-16253-F	Rotterdam,Netherlands	47.9	47.8	49.7
AL-16254-F	Rotterdam,Netherlands	45.5	44.8	46.1
AL-16255-F	Rotterdam,Netherlands	46.4	47.1	48.9
AL-16256-F	Rotterdam,Netherlands	44.8	44.7	45.8
AL-16418-F	Huelva,Spain	51.9	48.2	49.7
AL-16449-F	Rotterdam,Netherlands	46.7	47.2	49.0
AL-16450-F	Rotterdam,Netherlands	47.0	46.8	48.6
AL-16466-F	St Theodori,Greece	47.2	46.0	47.5
AL-16536-F	Rotterdam,Netherlands	46.7	46.5	48.2
AL-16662-F	St Theodori,Greece	45.5	45.6	47.2
AL-16663-F	St Theodori,Greece	45.3	45.5	46.9
AL-16676-F	Huelva,Spain	42.7	42.5	43.2
AL-16677-F	Port Jerome,France	44.9	44.5	46.4
AL-16741-F	Rotterdam,Netherlands	46.1	47.2	48.9
AL-16742-F	Rotterdam,Netherlands	45.1	46.1	48.1
AL-16743-F	Rotterdam,Netherlands	45.1	45.7	47.9
AL-16770-F	Port Jerome,France	45.2	45.4	47.6
AL-16771-F	St Theodori,Greece	46.0	46.5	48.4
AL-16844-F	Port Jerome,France	43.1	43.8	46.2
AL-16965-F	Priolo,Sicily	42.8	44.3	46.4
AL-17034-F	Port Jerome,France	45.3	46.8	48.6
AL-17042-F	Rotterdam,Netherlands	44.6	45.5	47.2
AL-17087-F	Castellon,Spain	41.8	42.1	43.3
AL-17114-F	St Theodori,Greece	45.9	45.8	48.0
AL-17115-F	St Theodori,Greece	47.3	45.5	47.7
AL-17129-F	Rotterdam,Netherlands	46.7	47.6	49.7
AL-17130-F	Rotterdam,Netherlands	47.1	47.0	48.8
AL-17131-F	Rotterdam,Netherlands	43.2	45.3	47.1
AL-17132-F	Rotterdam,Netherlands	44.6	46.7	48.4
AL-17186-F	Priolo,Sicily	44.7	45.3	48.9
AL-17215-F	Port Jerome,France	43.0	45.1	47.0
AL-17220-F	Castellon,Spain	39.6	39.9	41.3
AL-17228-F	St Theodori,Greece	43.7	44.5	45.3
AL-17229-F	St Theodori,Greece	43.8	44.2	46.3
AL-17230-F	St Theodori,Greece	44.4	45.8	47.9
AL-17231-F	Priolo,Sicily	47.9	46.2	49.2
AL-17259-F	Port Jerome,France	43.8	43.7	45.7
AL-17260-F	Priolo,Sicily	45.5	46.9	49.4
AL-17409-F	Port Jerome,France	45.0	46.6	48.8
AL-17425-F	St Theodori,Greece	44.4	45.1	47.3
AL-17426-F	St Theodori,Greece	44.0	44.9	46.8
AL-17493-F	Rotterdam,Netherlands	46.7	45.4	47.2
AL-17494-F	Rotterdam,Netherlands	47.3	44.9	46.5
AL-17495-F	Rotterdam,Netherlands	45.9	45.1	46.6
AL-17498-F	Rotterdam,Netherlands	46.6	45.8	47.7
AL-17505-F	Priolo,Sicily	47.9	45.9	48.9
AL-17533-F	St. Theodori,Greece	45.5	44.7	46.8

TABLE C-1. Cetane Values for JP-8 Fuels (Cont'd)

Lab Code	Location	Cetane No., D 613	Cetane Index, D 976	Cetane Index, D 4737
AL-17534-F	St. Theodori,Greece	45.1	44.6	46.8
AL-17542-F	West Germany	43.7	46.0	47.6
AL-17591-F	Rotterdam,Netherlands	44.6	44.8	46.0
AL-17593-F	St. Theodori,Greece	45.5	46.7	48.5
AL-17594-F	St. Theodori,Greece	45.1	47.6	49.3
AL-17601-F	West Germany	45.1	47.4	49.2
AL-17616-F	Castellon,Spain	42.0	40.4	43.2
AL-17617-F	Huelva,Spain	44.6	44.4	46.0
AL-17618-F	Huelva,Spain	43.7	41.7	42.5
AL-17619-F	Huelva,Spain	44.8	47.6	45.4
AL-17623-F	Rotterdam,Netherlands	43.6	46.3	47.8
AL-17624-F	Rotterdam,Netherlands	44.5	45.9	47.7
AL-17625-F	Rotterdam,Netherlands	44.5	44.2	45.5
AL-17627-F	Priolo,Sicily	45.0	46.3	49.2
AL-17638-F	Port Jerome,France	45.5	45.3	47.1
AL-17725-F	West Germany	44.0	45.6	47.5
AL-17736-F	St. Theodori,Greece	45.5	46.8	48.6
AL-17737-F	St. Theodori,Greece	46.0	46.2	48.0
AL-17738-F	St. Theodori,Greece	47.4	46.1	47.9
AL-17767-F	Priolo,Sicily	46.9	45.7	48.6
AL-17792-F	Port Jerome,France	44.3	45.6	47.6
AL-17828-F	Huelva,Spain	45.0	42.5	43.2
AL-17829-F	Huelva,Spain	41.4	43.7	44.9
AL-17830-F	Huelva,Spain	47.1	44.9	45.9
AL-17835-F	West Germany	37.8	31.6	35.6
AL-17907-F	Killingholme,England	43.7	44.2	45.1
AL-17908-F	Killingholme,England	44.5	43.7	44.8
AL-18105-F	St. Theodori,Greece	45.5	46.0	47.6
AL-18118-F	Rotterdam,Netherlands	46.0	46.4	48.1
AL-18123-F	Priolo,Sicily	46.3	45.9	46.6
AL-18133-F	Huelva,Spain	44.2	42.3	43.1
AL-18134-F	Huelva,Spain	44.1	42.8	43.7
AL-18144-F	Athens,Greece	45.5	45.8	47.5
AL-18147-F	Rotterdam,Netherlands	44.8	45.3	46.9
AL-18157-F	Rotterdam,Netherlands	47.2	47.2	49.0
AL-18180-F	Rotterdam,Netherlands	46.7	46.5	48.2
AL-18181-F	Priolo,Sicily	49.1	47.7	49.9
AL-18193-F	Athens,Greece	45.2	45.5	47.3
AL-18194-F	Athens,Greece	44.9	46.7	48.0
AL-18195-F	Rotterdam,Netherlands	46.6	46.8	48.7
AL-18202-F	Deer Park,Texas	42.6	43.9	45.0
AL-18203-F	Deer Park,Texas	43.6	44.6	45.7
AL-18212-F	Priolo,Sicily	46.3	46.1	48.8
AL-18218-F	Killingholme,England	44.7	45.9	46.6
AL-18219-F	Athens,Greece	44.8	44.4	46.0
AL-18221-F	San Roque,Spain	41.5	44.0	45.2
AL-18282-F	Priolo,Sicily	48.2	46.6	49.7
AL-18305-F	Huelva,Spain	46.7	42.2	45.1
AL-18306-F	Huelva,Spain	44.8	43.2	45.0
AL-18326-F	West Germany	39.0	36.2	39.9
AL-18348-F	Donges,France	40.2	40.6	42.9
AL-18349-F	Donges,France	41.7	40.9	43.8
AL-18350-F	Donges,France	43.2	42.4	42.4

TABLE C-2. Cetane Values for JP-5 Fuels

Lab Code	Location	Cetane No., D 613	Cetane Index, D 976	Cetane Index, D 4737
AL-16775-F	Deer Park,Texas	42.8	43.4	44.5
AL-16792-F	Abilene,Texas	44.4	46.1	47.3
AL-16794-F	Bakersfield, California	38.3	37.7	38.7
AL-16795-F	Bakersfield, California	37.6	37.7	38.6
AL-16796-F	Deer Park,Texas	41.1	44.3	45.2
AL-16824-F	Deer Park,Texas	42.7	44.5	45.6
AL-16825-F	Beaumont,Texas	44.0	43.8	42.9
AL-16826-F	Corpus Christi,Texas	44.3	45.2	46.4
AL-16828-F	Hanford,California	38.0	36.7	37.3
AL-16829-F	Hanford,California	39.4	37.5	38.0
AL-16830-F	Newhall,California	38.3	38.5	38.9
AL-16831-F	Newhall,California	38.5	38.8	39.3
AL-16833-F	Abilene,Texas	46.5	46.1	47.3
AL-16834-F	Newhall,California	39.4	39.5	39.8
AL-16835-F	Newhall,California	39.7	39.1	39.4
AL-16836-F	Deer Park,Texas	42.1	45.6	46.8
AL-16841-F	Deer Park,Texas	43.7	45.2	45.9
AL-16842-F	Newhall,California	39.0	39.8	39.8
AL-16845-F	Baton Rouge,Louisiana	43.5	43.9	44.5
AL-16846-F	Ewa Beach,Hawaii	43.6	41.8	42.3
AL-16854-F	Corpus Christi,Texas	44.3	47.1	49.0
AL-16856-F	Newhall,California	37.7	39.2	39.4
AL-16857-F	Newhall,California	38.3	38.8	39.1
AL-16858-F	Newhall,California	38.2	39.3	39.5
AL-16859-F	Newhall,California	38.5	39.0	39.4
AL-16861-F	Deer Park,Texas	45.1	44.9	46.3
AL-16862-F	Newhall,California	39.3	38.9	39.2
AL-16863-F	Augusta,Sicily	43.7	45.7	47.1
AL-16864-F	Ferndale,Washington	40.9	40.6	42.6
AL-16865-F	Newhall,California	39.2	39.0	39.4
AL-16866-F	Corpus Christi,Texas	43.9	45.9	47.6
AL-16917-F	Baton Rouge,Louisiana	46.3	43.7	44.2
AL-16918-F	Abilene,Texas	45.2	45.9	47.3
AL-16919-F	Baton Rouge,Louisiana	43.6	43.4	43.8
AL-16958-F	Abilene,Texas	46.2	46.7	48.0
AL-16961-F	Newhall,California	37.8	39.4	41.6
AL-16962-F	Baton Rouge,Louisiana	42.5	43.7	44.8
AL-16963-F	Deer Park,Texas	44.9	45.0	46.3
AL-16964-F	Deer Park,Texas	42.7	44.8	45.9
AL-16969-F	Newhall,California	38.5	39.6	39.8
AL-16970-F	Newhall,California	38.4	39.4	39.6
AL-17043-F	Three Rivers,Texas	44.8	43.7	45.2
AL-17044-F	Newhall,California	39.2	38.9	39.3
AL-17047-F	Corpus Christi,Texas	47.0	47.4	49.4
AL-17055-F	Baton Rouge,Louisiana	45.5	43.9	44.6
AL-17057-F	Baton Rouge,Louisiana	44.8	44.3	44.9
AL-17058-F	Baton Rouge,Louisiana	45.1	44.5	45.1
AL-17059-F	Abilene,Texas	46.6	46.5	47.9
AL-17060-F	Ferndale,Washington	40.8	42.1	44.0
AL-17061-F	Ferndale,Washington	41.4	42.3	44.3
AL-17062-F	Baton Rouge,Louisiana	47.3	45.4	46.2
AL-17063-F	Baton Rouge,Louisiana	44.6	44.5	45.1
AL-17068-F	Newhall,California	39.4	39.8	40.0
AL-17069-F	Newhall,California	38.2	39.0	39.5
AL-17070-F	Newhall,California	38.8	39.0	39.4

TABLE C-2. Cetane Values for JP-5 Fuels (Cont'd)

Lab Code	Location	Cetane No., D 613	Cetane Index, D 976	Cetane Index, D 4737
AL-17071-F	Newhall, California	38.5	39.5	39.9
AL-17072-F	Deer Park, Texas	43.1	44.4	45.4
AL-17073-F	Deer Park, Texas	43.1	44.5	45.5
AL-17082-F	Pasadena, Texas	43.5	45.0	46.1
AL-17083-F	Baton Rouge, Louisiana	46.7	45.2	45.9
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